1969

Analysis of demand for corn, beans, wheat and rice in Mexico

Mateo Vazquez-Morales
Iowa State University

ANALYSIS OF DEMAND FOR CORN, BEANS, WHEAT AND RICE IN MEXICO

by

Mateo Vazquez-Morales

A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
MASTER OF SCIENCE

Major Subject: Agricultural Economics

Iowa State University
Of Science and Technology
Ames, Iowa

1969

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The success of agricultural development in Mexico during the last twenty-five years is evident. This development is without a doubt the result of government programs, accomplished with the purpose of satisfying the national needs and to favor the commercial balance in the role of agricultural products. These programs of development have reached the goal of increasing production as well as agricultural productivity. In the particular case of certain subsistence crops, development has been such that at the present serious problems have arisen concerning overproduction is apparent since potential demand of subsistence crops has not yet been satisfied due principally to the low purchasing power of a large sector of the population.

During the last few years there has been interest in carrying out research in the field of agricultural economics. This interest stems from the desire to try to resolve a few socio-economic problems which have been presented in the process of agricultural development; and on the other hand, with the purpose of taking into account basic studies for agricultural planning, thus avoiding policy errors in the future.

Up until the present, the major part of the work done has been focused in the field of production economics and general agricultural economics. Little emphasis has been given to studies related to the marketing of agricultural commodities. Currently there exists very little information concerning the different phases of marketing of agricultural products and about the different factors which affect demand for food in general or for a single product in particular. Studies made on supply,

demand and price structure are fundamentally used for the formulation of price policies directed to foment general economic growth or as a base for the formulation of agricultural programs through which can be obtained an efficient allocation of resources among the different economic activities. On the other hand, studies of this nature not only permit a more complete understanding of the performance of agricultural economics, but also allow predictions to be made concerning future necessities of agricultural products.

The main reason this present work was carried out was to know the performance of demand for four basic agricultural commodities (corn, beans, wheat and rice) as well as the future implications of such behavior.

Among the specific objectives it was intended (1) to identify the principal factors which affect the demand for the four commodities under consideration, (2) to estimate the price and income elasticities of demand, and (3) to determine the feasibility of using available data on studies of this nature.

In the first part of this work, reference is made to several previous studies. The way in which principal factors such as prices, income and population affect demand in general is discussed. The trends of change in the area harvested, yields, production, consumption, prices and foreign trade of the four commodities under study is also described.

In the second part, the model of analysis is presented. A discussion is also made concerning statistical information, as well as the sources and adjustments which were necessary for the analysis. Finally, the results are shown, and the causes for which such results were arrived at are discussed as well as some conclusions derived from the study as a whole.

I. PART ONE: DEMAND AND CONSUMPTION OF BASIC FOOD PRODUCTS IN MEXICO

A. Brief Review of Mexican Studies on Supply and Demand

Literature on studies of supply of and demand for agricultural products in the case of Mexico is very poor and in fact is reduced to five studies.

Following is a brief discussion on the results obtained in such previous studies concerning this subject, whether it be for total agricultural products or for a product in particular.

The first study on supply of agricultural products was done by Pablo Padilla[1] (1938), in which he makes an estimate of price elasticity of the aggregate supply of agricultural products. His work is not a demonstration of complicated methodology; on the contrary, it is simple and has the distinction of being a pioneer in making a study of the conduct of the aggregate supply of Mexican agricultural production.

Another study, in this case for a particular crop (wheat), was carried out by the author[2] of the present study. In this work, one of the main objectives was to estimate the price and income elasticities of demand. The study was based on the use of time series data and included the period from 1925 to 1960. The following results were obtained: price

---

[1] Padilla, Pablo. Elasticidad en la Oferta de la produccion Agricola. Banco Nacional de Credito Ejidal. Boletin de Estudios Especiales 132. Vol. 11. Julio, 1958.

[2] Vazquez Morales, Mateo. Analisis Estadistico de la Demanda de Trigo en Mexico. Unpublished thesis. Chapingo, Mexico, Library, National School of Agriculture. 1963.

elasticity of -1.60, income elasticity of 0.80, and an average increase in demand of 6% annually. Even though the results were congruent with the hypothesis (that $\varepsilon_p < 0$ and $\varepsilon_y > 0$), due to the fact that the data were used without any adjustment from that which will be discussed subsequently, it is very possible that such estimates are somewhat high. However, the fact that the consumption increased during the period 1925 to 1960 from 300,000 to 1,500,000 tons while the population augmented from 14,000 to 34,923 inhabitants, a higher value is to be expected for both elasticities.

Later the Bank of Mexico, S.A., through its Office of Agricultural Projections, carried out a study to make supply and demand projections of agricultural products for 1965, 1970 and 1975, whose results were published in August of 1966.[3]

This is one of the most complete studies on the subject and enjoys the merit of being one in which a larger volume of statistical information was collected and processed. The information used was obtained through a survey at the national level on family budgets and from annual statistical data.

In their results which they used as a base for their projections, they report estimates of income elasticities for the urban and rural sectors, using time series as well as cross section data. These results are shown in Table 1.

---

[3]This study was carried out under an agreement between the Economic Research Service, U.S. Department of Agriculture and the Bank of Mexico, S.A.

Table 1. Income elasticities for 1963

Source of Data	Time Series	Cross-section Data	
Crop	Total	Urban	Rural
Corn	-0.38	-0.484	-0.294
Beans	0.48	-0.282	-0.237
Wheat	0.57	0.247	0.579
Rice	0.46	0.190	0.648

The estimates of the elasticities, derived from time series data, were calculated from simple relations between per capita consumption in physical units and per capita gross national product at 1960 prices. In the case of the analysis with cross-section data, relations between consumption of the commodity in per capita physical units and total consumption expenditures in per capita terms were used.

A contradiction exists in the results with respect to beans since the derived income elasticity from cross-section data resulted with opposing signs to the calculated elasticity from the annual series. On the other hand, the estimates arising from cross-section data in which total expenditures on consumption were used as the variable which represents income, will be valid if and only if the total expenditure elasticity with respect to income is equal to one.[4]

[4] According to the equation used in the estimation of the elasticity:

$$q = aV^b = a(P \cdot Q)^b$$

in which q = per capita consumption in physical units; V = total consumption expenditures = $P \cdot Q$, and according to the definition of point elasticity it can be shown that:

$$b = \frac{\partial q}{\partial V} \cdot \frac{V}{q}$$

(footnote 4 continued on next page)

The previous comments are not intended to detract from the value or quality of the study above mentioned; on the contrary, it is only to point out several possible alternatives for future investigations, whether it be to refine these results or accept them as the best estimates.

(footnote 4 continued from previous page)

which is the elasticity of demand with respect to total expenditures. On the other hand, income elasticity properly defined is as follows:

$$\eta_y = \frac{\partial q}{\partial Y} \cdot \frac{Y}{q}$$

in which η_y is the income elasticity and Y is income. Finding the value of $dq/q = \eta_y(dY/Y)$, and now substituting this value in the formula above, the following expression remains: $b = \eta_y(dY/Y)(V/dV)$. Finding the value of η_y it becomes:

$$\eta_y = b(dV/dY) \cdot (Y/V) = b\eta_g$$

Since $V = P \cdot Q$

Taking the total differential,

$$dV = P \cdot dQ + Q \cdot dP$$

now multiplying by Y/V and dividing by dY both members, the resulting expression can be written,

$$(dV/dY) \cdot (Y/V) = P(dQ/dY) \cdot (Y/V) + Q(dP/DY) \cdot (Y/V)$$

substituting the value of $V = P \cdot Q$ in the second term of the expression above it is reduced as follows:

$$(dV/dY) \cdot (Y/V) = (dQ/dY) \cdot (Y/Q) + (dP/dY) \cdot (Y/P)$$

The right side of this equation is the elasticity of total expenditures with respect to income (η_g). The second term is the sum of both the income elasticity and an elasticity of price with respect to income defined as η_y and η_c respectively. η_c is known as "quality elasticity". The equation can be written as:

$$\eta_g = \eta_y + \eta_c$$

But since, $\eta_y = b(\eta_y + \eta_c)$ from which we have

$$\eta_y = \frac{b}{1-b}\eta_c$$

In the above, the only case in which $\eta_y = b$ is when $\eta_c = 1-b$, which is equivalent to the statement that η_y will be estimated by b if and only if the elasticity of total expenditures with respect to income is equal to one.

In spite of the limitations this work may have, it represents a great step in the study of demand for agricultural products in Mexico. It presents the current scope of supply and demand as well as their probable projections for 1965, 1970 and 1975, thereby having a firm basis to plan future agricultural policy.

B. Principal Factors Which Affect Demand

Supply and demand theory has developed under the assumption that the individual is a sort of "psychological machine". The individual as seller or producer supposedly followed rational principles such as how to equal his marginal revenue with his marginal costs. As buyer he supposedly tries to maximize satisfaction of his preferences.

In the above mentioned study concerning agricultural projections, only the effect of changes in income on consumption of agricultural products was considered. Nevertheless, the effect which consumption can have on changes in prices was not analyzed. Neither were the effects of other variables related to demand. (Such variables can be prices of competitive commodities.) In the case of time series analysis, such variables could be the prices of competitive and complementary commodities. In the case of the cross-section analysis in which only the level of income varies but where the prices refer to a given level, it would be convenient to include variables such as family composition, geographic distribution of population, level of education, average age of family, etc. Some explanation of the way these variables affect the demand is given below.

1. Effect of price changes

In general, as the price of a commodity decreases, consumers will be willing to buy more of that commodity and vice versa, with the exception of those goods in the market for speculative purposes (bonds, stocks, etc.). These purchases are subject to price expectations.

It is also known that the response of consumption to changes in prices is of a different magnitude depending on the product under consideration. The degree of responsiveness to price changes is measured by the so-called price elasticity.[5] The degree of the price elasticity depends principally on the existence of substitutes.

In the case of a country with a low level of development in which food demand is not yet satisfied due mainly to the low purchasing power of the majority of the population, price elasticities are expected to be high.

Another assumption is that if the acquisition of a good or service is positively correlated with income, the demand of such goods or services will be price elastic.

2. The effect of changes in income

The purpose of demand analysis is to study the behavior of the different factors affecting the demand within a community or economy. In order to arrive at an aggregated generalization, it is convenient to start with the characteristics of the unit of analysis, that is, the individual.

---

[5]The price elasticity of demand is defined as the quotient between the percentage change of the quantity purchased and the percentage change in the price of the commodity.

In this way, the reaction of the individual can be used to explain the general economic phenomena, in this case, the market.

George J. Stigler[6] first treats the individual reaction to changes in income and later from the individual reactions he arrives at conclusions for the aggregate behavior in general.

If the individual income rises, he will be in a position to increase his purchases of goods and services. It is also possible that such an increase will occur on some items but not in all of them. In this particular case, Stigler states that the increase in income might not affect the purchases on salt or cigarettes, and will negatively affect the purchases on low quality goods. He also states that 1) "the current purchases of an individual are more greatly influenced by the average income from various previous years than by current income" and 2) that "in the short run, the reaction to a permanent change in income will be different from the reaction in the long run."[7]

In the short run, an individual with a low income would consume more than he earns, but in the long run he will adjust his expenses according to his earnings. On the other hand, if a permanent change in his income occurs, it will take a certain period of time for him to adjust to a new consumption pattern.

The conclusion of the above is that the consumers will buy more of a good or service or they will be willing to pay more for the same good or service but of a better quality as their income rises. However, there will

---

[6] George J. Stigler. The Theory of Price. Tenth Printing. New York, N.Y. The Macmillan Company. 1961. pp. 49-52 and 60-61.

[7] Ibid. p.60.

be a ranking of goods and services consumed, in other words, as soon as the individual satisfies his needs of food, he will spend more on clothes, on movies, in traveling, etc. The above is better known in consumption theory as the "Engel Law". Engel observed that as the individual consumer's income rises, a decreasing proportion of it is spent on food. The concept of income elasticity is a more precise derivation of Engel's Law. The income elasticity gives a measure of the changes experienced by the demand as the individual, family or national income changes.[8]

The income elasticity coefficient can be positive or negative. If the quantity purchased of a good decreases as income rises, the income elasticity coefficient is negative. Goods with such characteristics are called "inferior goods". If the quantity purchased of a good increases as income increases, the coefficient is positive. Goods of this kind are called "superior goods". If the coefficient is equal to zero, then the commodity or service is known as an "intermediate good".[9]

According to Schultz classification, the following questions arise: In an economy such as Mexico's, with a low level of development, with different tastes, customs and tradition, does the classification of food according to Schultz have the same behavior? Is that which is an inferior

---

[8] Income elasticity of demand is defined as the quotient between the percentage change of the quantity purchased and the percentage change in income.

$$Ey = \frac{\text{Percentage change in quantity purchased}}{\text{Percentage change in the price of the commodity}}$$

[9] Based on the results of several studies on demand of food in the United States, T. W. Schultz elaborates a complete classification of the elasticities of the above three groups of goods, in his Economic Organization of Agriculture, McGraw Hill Book Company, Inc. 1953. pp. 71-72.

good to the American also the same for a Mexican consumer? Probably in certain cases it is similar but in others undoubtedly not. Therefore, to answer the above questions, it is necessary to carry out studies of this nature.

Another problem also arises. Does the aggregated demand respond in the same manner with respect to changes of total or national income as in the case of the individual consumer? In the only case in which this would occur would be where the prices were equal for all consumers, that their income were equal and moreover that they all had the same allocation of income for a particular good. However, this never occurs. "The effect of an increase in income, therefore, says Stigler,[10] depends on how the income is distributed initially and how the increases in income are distributed."

In order to carry studies to measure the effects of income on consumption, they must be based on the assumption that the distribution of income remains constant just as the increases in the same are proportional.

3. Population

The demographic factors are also important in the determination of the national per capita average and on consumption in particular. These factors are: (a) distribution by age groups; (b) geographic population distribution; (c) rural and urban distribution and (d) family size and composition.

a. Population distribution by age groups How do the changes in age distribution affect per capita food demand? This question is difficult

---

[10] Stigler, op. cit., p. 61.

to answer since few studies have been made to analyze its effects. However, it is possible to expect that by changing age distribution, changes in consumption will take place. (See Table 17 in the Appendix.)

b. Geographic population distribution Changes in geographic population distribution are likely to affect regional but not national per capita averages. However, the importance of such distribution lies in the changes of interregional trade. (See Table 18 in the Appendix.)

c. Population distribution of the rural and urban sectors As the percentage of rural population decreases by emmigration to the cities, changes in the aggregated demand of food occur. The products which the rural population consume on the farm will be changed either in the short or long run by other types of diets more accessible in the city. On the other hand, while the farmer remains on the farm, especially the poor farmer, he is not part of the market, but when he moves to the city he automatically is incorporated into the food market in general. (See Table 19 in the Appendix.)

d. Size and family composition The size as well as the composition of the family are also factors which affect food demand, yet it is difficult to prove it.

Since the low level of development of the Mexican rural sector as a whole is still in a stage of subsistence, the population distribution either rural or urban can greatly affect the consumption of a particular commodity. Such a situation implies that the rural sector does not respond easily to the market conditions with respect to agricultural subsistence products. If this hypothesis is true, demand for the two sectors would

have to be analyzed separately. Although for this end the problem of adequate statistical information of chronological series exists, it would be possible to carry this out by means of cross-section analysis.

C. Area, Yield and Production

Due to the fact that supply of agricultural commodities in each year is an important factor that determines the prices of these commodities as well as their utilization, it would be useful to examine the principle factors that have caused changes in production in the short and in the long run.

During the 1930-39 decade, the trend of production of corn and beans was lightly upward at a compound rate of growth of 0.06% and 0.31% annually respectively; for wheat there was a lightly negative trend with a compound rate of -0.04% annually and for beans there was an upward trend of 2.73% compounded annually.

For corn as well as for beans, this trend was the result of the combined changes in yields and in the area harvested. In the case of wheat, area harvested and yields practically remained unchanged. The increase in rice production was due mainly to the increase of 2.23% annually in the area planted.

In general the stagnation of production during the 1930-39 period, was due principally to a decrease in the area planted with light increases in yields. The reason of this decrease in the area planted can be attributed principally to a heavy activity of land reform.

Since 1938, production of the four commodities began to present an upward trend, rising greatly during the period 1954-65. (See Tables 2, 3,

Table 2. Corn: compounded rates of growth of area, yield and production,[a] in five selected periods, 1930-65

Period	Area	Yield	Production
	Percent	Percent	Percent
1930-39	-0.32[b]	0.54[b]	0.06[b]
1940-53	2.58*	2.75*	5.33*
1954-65	3.31*	3.39*	6.39*
1940-65	3.59*	2.53*	6.12*
1930-65	2.83*	2.06*	4.80*

[a]The rates were calculated by means of regressions between the logarithm of the growth variable and an index of time.

[b]Indicates $t_{cal.} < t_{gl, 0.10}$.

*Note: The rest is indicated with a $t_{cal.} > t_{gl, 0.01}$.

4 and 5.)

The main factors that have been contributing to the increase of production are mainly the increases in the area planted and yields. The improvement in yields is the result of the increasing area cultivated under irrigation, the increasing use of fertilizer, improved seeds, machinery and pesticides. Tables 20, 21, 22 and 23 in the Appendix as well as Figures 7, 8, 9 and 10 in the Appendix show more clearly the above mentioned changes.

Table 3. Beans: compounded rates of growth of area, yield, and production[a], in five selected periods, 1930-65

Period	Area	Yield	Production
	Percent	Percent	Percent
1930-39	-2.36[c]	2.74[b]	0.31[b]
1940-53	3.38*	2.63[c]	6.00*
1954-65	5.75*	1.68[c]	5.17[c]
1940-65	4.62*	3.37*	7.35*
1930-65	4.11*	2.72*	6.20*

[a]The rates were calculated by means of regressions between the logarithm of the growth variable and an index of time.

[b]Indicates a $t_{cal.} < t_{gl, 0.10}$.

[c]Indicates a $t_{cal.} > t_{gl, 0.05}$.

*Note: The rest is indicated with a $t_{cal.} > t_{gl, 0.01}$.

Year to year variations on production are due mainly to effects of weather, since most of corn, beans and wheat production were produced in areas under rainfall. Another source of year to year variation is the reaction of the farmers to economic factors, i.e., if the production of one year is low, the farmers' reaction is to try to produce more for the next year. This reaction is based on farmers' expectation of higher prices due to the shortage.

Table 4. Wheat: compounded rates of growth of area, yield, and production,[a] in five selected periods, 1930-65

Period	Area	Yield	Production
	Percent	Percent	Percent
1930-39	0.31[b]	0.13*	-0.04[b]
1940-53	1.08[b]	2.25*	3.09[c]
1954-65	-1.56*	6.78*	5.22*
1940-65	2.22[d]	4.75*	6.20*
1930-65	1.80*	2.98*	4.78*

[a]The rates were calculated by means of regressions between the logarithm of the growth variable and an index of time.

[b]Indicates a $t_{cal.} < t_{gl, 0.10}$.

[c]Indicates a $t_{cal.} > t_{gl, 0.05}$.

[d]Indicates a $t_{cal.} > t_{gl, 0.10}$.

*Note: The rest is indicated with a $t_{cal.} > t_{gl, 0.01}$.

Table 5. Rice: compounded rates of growth of area, yield, and production[a], in five selected periods, 1930-65

Period	Area	Yield	Production
	Percent	Percent	Percent
1930-39	2.23[b]	-0.16[c]	2.73[b]
1940-53	4.65*	-0.46[c]	4.19*
1954-65	3.93*	0.07*	5.23*
1940-65	3.97*	0.05*	4.00*
1930-65	4.79*	0.02*	4.81*

[a]The rates were calculated by means of regressions between the logarithm of the growth variable and an index of time.

[b]Indicates a $t_{cal.} < t_{gl, 0.10}$.

[c]Indicates a $t_{cal.} > t_{gl, 0.10}$.

*Note: The rest is indicated with a $t_{cal.} > t_{gl, 0.01}$.

D. Consumption, Prices and Foreign Trade

1. Consumption

The apparent consumption of the four commodities under study have experienced a steady increment during the last 38 years, following similar trends such as those of production. In Table 6 the annual figures of apparent consumption are summarized as reported by the DGEA (General Bureau of Agricultural Economics) as well as the adjusted figures. The estimates of apparent consumption as shown in Table 6 do not clearly reveal the annual fluctuations on consumption, due to the fact that they include changes in inventories. Therefore, it is not possible to arrive at any final conclusions about the annual variations in consumption. In general, consumption has increased in absolute terms as well as in relative terms; that is, the increase in consumption is due not only to the increase in population but of other factors, the most important being the rise in the purchasing power of the consumers. Table 7 summarizes the increases in per capita consumption of the four commodities under study.

2. Prices

Farm prices of the four commodities as well as wholesale prices show a downward trend during the 1930-34 period. The main reason was the effect of the 1930 world depression. Since 1935, the trend rose lightly until 1943 for the wholesale prices and until 1944 for the farm prices. From 1945 to 1958 the trend rose strongly for corn, beans and wheat. Since 1959, the trend was toward stabilization. The prices of rice remained on the upward trend. See Figures 1 and 2.

Table 6. Apparent consumption of corn, beans, wheat and rice[a] (thousands of tons)

Year	Apparent Consumption DGEA				Corrected Apparent Consumption[b]			
	Corn	Beans	Wheat	Rice	Corn	Beans	Wheat	Rice
1930	1,456	86	440	52	2,060	81	357	80
31	2,158	144	555	45	2,828	142	479	76
32	1,974	132	313	48	2,708	132	244	81
33	1,924	180	349	40	2,723	182	333	75
34	1,652	112	555	39	2,517	116	301	76
1935	1,594	115	347	30	2,523	126	301	70
36	1,593	106	440	46	2,487	114	401	88
37	1,638	103	347	31	2,698	114	317	76
38	1,715	106	476	49	2,838	119	453	96
39	1,851	152	480	68	3,219	174	459	118
1940	1,648	96	465	73	2,923	129	447	123
41	2,124	152	558	67	3,485	197	542	117
42	2,362	171	609	51	3,811	227	595	99
43	1,809	152	661	75	3,341	220	649	124
44	2,480	178	813	63	4,099	258	801	111
1945	2,235	155	659	80	3,940	246	649	129
46	2,392	137	600	94	4,182	240	593	143
47	2,518	201	701	83	4,395	315	697	131
48	2,832	210	764	79	4,795	335	763	127
49	2,856	231	745	81	4,904	368	746	127
1950	3,122	250	1,014	123	4,972	381	996	168
51	3,475	252	968	119	5,126	379	931	161
52	3,227	309	965	100	4,678	431	908	141
53	4,099	348	920	101	5,351	466	844	140
54	4,635	418	908	112	5,688	530	814	150
1955	4,438	448	860	139	5,286	556	746	174
56	4,500	431	1,327	154	5,155	533	1,195	188
57	5,312	413	1,396	153	5,768	510	1,268	185
58	6,087	548	1,337	159	6,344	639	1,167	189
59	5,611	506	1,266	163	5,670	709	1,076	192
1960	4,955	553	1,190	236	4,814	635	981	253
61	5,592	627	1,373	222	5,252	704	1,145	247
62	6,434	652	1,484	130	5,895	729	1,198	153
63	7,345	654	1,681	199	6,704	721	1,416	220
64	5,931	694	1,178	198	5,005	755	893	218
1965	7,669	914	1,742	220	6,529	971	1,438	239

[a]Source: Direccion General de Economia Agricola (S.A.G.), Censo Agricola Ganadero Ejidal (1930, 1940, 1950 and 1960), (S.E.N. and S.I.C. - Secretariat of National Economy and Secretariat of Industry and Commerce), Mexico.

[b]Adjusted with the adjusted production.

Table 7. Per capita consumption,[a] four subsistence crops (kilograms per person), 1930-65

Year	Corn	Beans	Wheat	Rice
1930	124.6	4.9	21.6	4.8
1940	148.7	8.9	22.7	6.3
1950	190.0	14.3	38.6	6.5
1960	137.9	18.2	29.6	7.5
1965	157.2	23.4	34.6	5.7

[a]Calculated with corrected domestic use data and the population series which appear in Tables 8, 9, 10, 11 and 12.

During the whole period 1931-65, farm prices rose 14.7, 12.6, 9.6 and 10.1 times for corn, beans, wheat and rice respectively. For wholesale prices such increase was of the order of 8.1, 9.1, 7.6 and 10.4 times for the same commodities.

The margin between farm and wholesale prices for the 1930-32 average was 0.80, 0.79, 0.48 and 1.55 percent for corn, beans, wheat and rice respectively. For the 1963-65 average such margins were 0.40, 0.32, 0.20 and 1.55 for the same items.

The reduction in the margins evidently shows the effect of the price control programs especially during the last ten years. During the 1930-40 period, although there already existed a price control agency, its performance was of less importance. Therefore, the intermediates absorbed these wide margins.

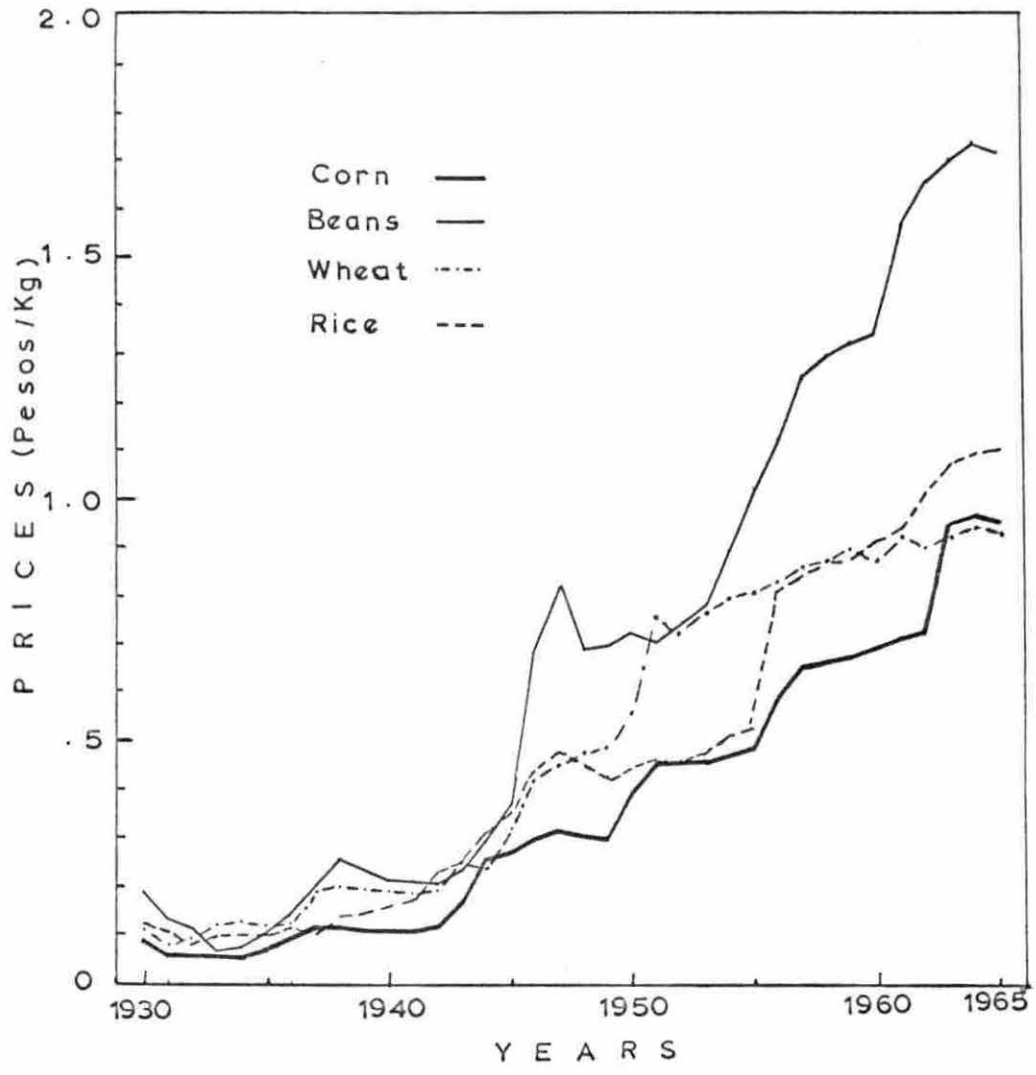


Figure 1. Annual fluctuations of farm prices for four subsistence commodities, 1930-65

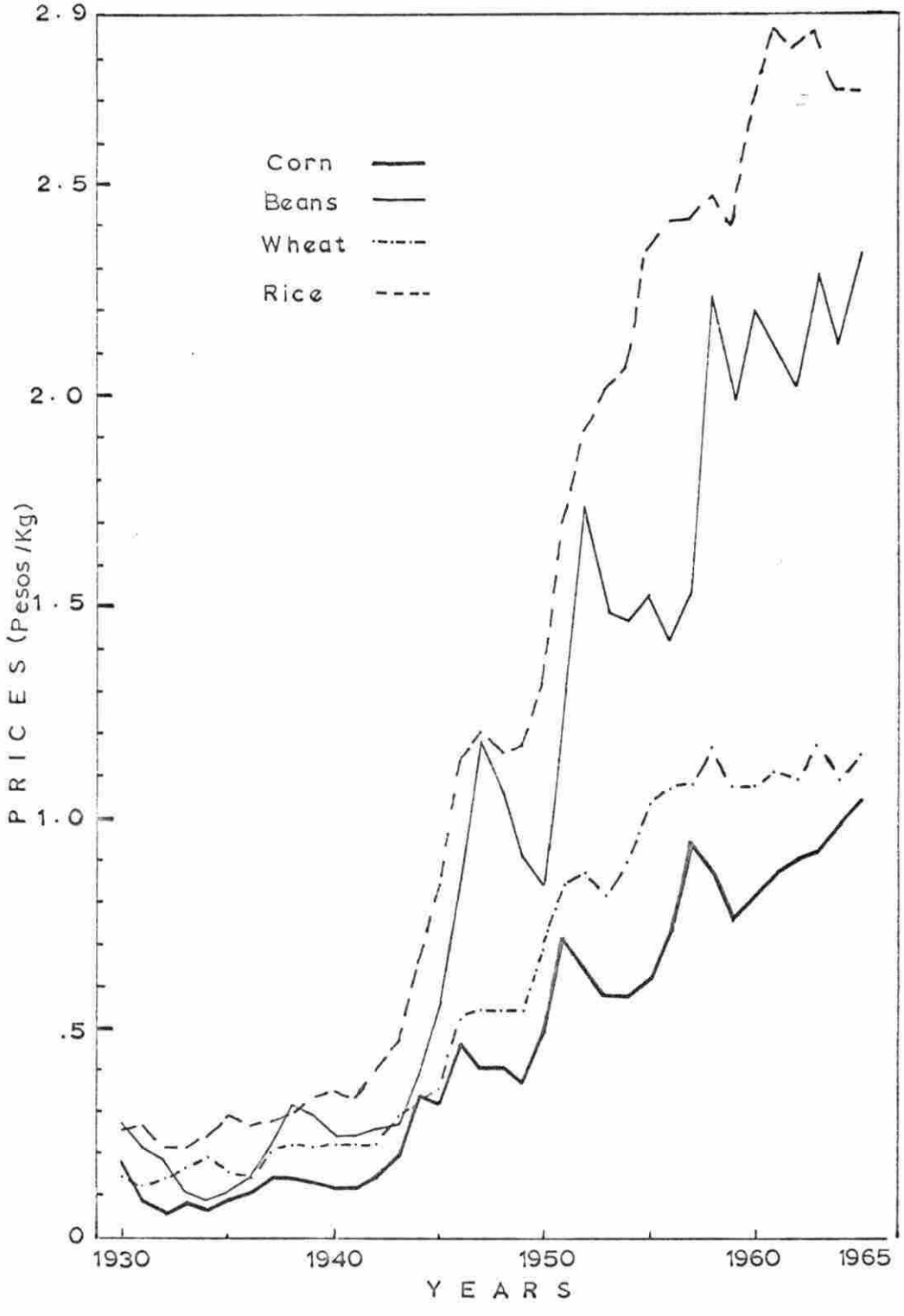


Figure 2. Annual fluctuations of wholesale prices for four subsistence commodities, 1930-65

Due to the fact that CONASUPO (Official Mexican Price Control Agency) operates in greater scale with corn, wheat and beans, the margins between the farm and wholesale prices are less than for rice.

3. Foreign trade

Foreign trade of the four commodities can be considered of negligible importance in the Mexican balance of payments. However, imports of corn, wheat and beans have been greater than the exports; in the case of rice, it has been the opposite.

In general, imports have moved in opposite direction to the domestic production, that is to say that imports have been made in order to cover the deficits of the total supply when the domestic production has been below the consumption requirements.

The greatest imports in corn have never surpassed 16% of the domestic production and for beans 18%. For wheat, imports were of more importance from 1938 until 1957, reaching peaks in 1950 and 1952 in the order of 50% of the domestic production in those years. With respect to exports from 1930 to 1960, they can be considered meaningless for all practical purposes. Only in the last five years has the production of wheat, corn and beans increased above the domestic demand. Exports therefore have gained importance. See Tables 24, 25, 26 and 27 in the Appendix which show the foreign trade of the commodities in question.

II. PART TWO: STATISTICAL ANALYSIS

A. The Model

The selection of the analytical model is the most important aspect in the analysis of demand. Such selection includes the form of the algebraic expression to be used and the variables to be included.

The determination of the model is not an automatic process. It has to be elaborated on grounds of a full appreciation of the theoretical aspects of the problem, the researcher's knowledge of the commodities under study as well as the awareness concerning the limitations of the data.

The theory of demand establishes that for an individual, the quantity purchased of a commodity depends on the price of such commodity, on the prices of competitive and complementary items, on the disposal of income and on other forces related to tastes and preferences. The above set of relationships can be represented in functional form as follows:

$$q = f(P_1, P_2, P_3, \ldots, P_n, Y, u) \qquad (1)$$

where "q" represents the total consumption of the commodity, P_1 is the price of "q", P_2, P_3, ..., P_n are the prices of other commodities included in the model; "Y" is income; u is a disturbance error term and "f" the form of the algebraic expression of the function.

The method to be used in order to estimate demand coefficients depends on the assumption about the nature of the functional relationships generated by the different variables included. One of the main assumptions used in demand analysis is that which considers production and consumption of agricultural products as essentially pre-determined; in other words, the assumption of an inelastic supply.

If it is assumed that the consumption of two competitive commodities is independent of their respective prices during a given period of time, the usual procedure used to estimate demand coefficients consists of taking the price of each commodity as a function of the two quantities and of income and fitting each equation separately. This procedure gives "biased" estimates when it is used for two or more competitive commodities, due mainly to the fact that their prices are jointly determined by the interactions of both supply and demand factors of each commodity. If that is the case, the best method consists in formulating a model in which the structural coefficients could be estimated simultaneously.

In the particular case of the commodities under study, these latter were included tentatively in a model of the above nature, under the assumption of a given supply and the assumption that their prices are simultaneously determined.[11] Such a model includes four structural equations as shown below.

$$\begin{aligned} q_c &= f_1 (P_c; P_b; P_w; P_r; I; Z's) \\ q_b &= f_2 (P_c; P_b; P_w; P_r; I; Z's) \\ q_w &= f_3 (P_c; P_b; P_w; P_r; I; Z's) \\ q_r &= f_4 (P_c; P_b; P_w; P_r; I; Z's) \end{aligned} \qquad (2)$$

in which c, b, w, and r refer to corn, beans, wheat and rice respectively; the q's represent consumption and the P's their respective prices; "I" represents income and the Z's other predetermined variables.

---

[11] Foote, Richard J. Analytical tools for studying demand and price structures. U.S. Dept. Agr. Agr. Handbook 146. 1958.

The previous model is "just identified". For that reason, transforming the model to its reduced form, it is possible to calculate it by the method of least squares.

In this first stage of the analysis, two different formulations were used. The first consisted in using a single equation model to estimate the demand function for each commodity under study; the second consisted in the using of the simultaneous model for competitive commodities described earlier.

The first formulation is as follows:

$$\begin{bmatrix} q_m \\ q_b \\ q_w \\ q_r \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} P_c \\ P_b \\ P_w \\ P_r \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \\ b_{41} & b_{42} & b_{43} \end{bmatrix} \begin{bmatrix} I' \\ I \\ P_p \end{bmatrix} \quad (3)$$

In the previous single model, the variables were taken in their logarithmic form and expressed as deviation of their respective mean; the q's are quantities consumed in per capita terms, the P's represent prices, "I" represents per capita income, a_{ij} are cross elasticities when $(i \neq j)$ and they are the price elasticity when $(i = j)$.

The $b_{i1} = \beta\gamma$ in which β is the parameter associated with βY and γ is the percent of rural with respect to total population. The b_{i2} are the parameters associated with "I"; in other words, $(b_{i1} + b_{i2})$ = total income elasticity. The b_{i3} for $i = 1$ is the parameter associated with the consumption of corn and price of pork, for $i \neq 1$, $b_{i3} = 0$.

The second formulation is as follows:

$$\begin{bmatrix} q_c \\ q_b \\ q_w \\ q_r \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} P_c \\ P_b \\ P_w \\ P_r \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \\ b_{41} & b_{42} & b_{43} \end{bmatrix} \begin{bmatrix} I' \\ I \\ P_p \end{bmatrix} \qquad (4)$$

The notation in (4) is the same as in (3) with the exception that in (4), b_{i3} for $(i = 1, 2, 3, 4) \neq 0$.

This simultaneous model can be converted to its "reduced form" for computation purposes so that it is possible to calculate the equations directly. Later, by means of algebraic manipulations, it is possible to estimate the structural system.

The "reduced form" equations are represented as follows:

$$\begin{bmatrix} q_c \\ q_b \\ q_w \\ q_r \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} & A_{14} \\ A_{21} & A_{22} & A_{23} & A_{24} \\ A_{31} & A_{32} & A_{33} & A_{34} \\ A_{41} & A_{42} & A_{43} & A_{44} \end{bmatrix} \begin{bmatrix} q_c \\ q_b \\ q_w \\ q_r \end{bmatrix} + \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \\ B_{41} & B_{42} & B_{43} \end{bmatrix} \begin{bmatrix} Z_1 \\ Z_2 \\ Z_3 \end{bmatrix} \qquad (5)$$

In matrix notation, expression (5) can be expressed as in (6):

$$\underset{(4x1)}{P} = \underset{(4x4)}{A}\ \underset{(4x1)}{Q} + \underset{(4x3)}{B}\ \underset{(3x1)}{Z} \qquad (6)$$

Pre-multiplying both members of equation (6) by the inverse of A, that is, A^{-1} and expressing Q in terms of P and Z as follows:

$$Q = A^{-1} P - A^{-1} BZ \qquad (7)$$

which is the original structural form in which $A^{-1}_{ij} = a_{ij}$ and $(A^{-1} B)_{ij} = b_{ij}$.

After many attempts to adjust the model, adding or eliminating variables, transforming them and using different periods of time, the

results obtained were not satisfactory. The income variable was the principal problem in analyzing the results. Initially, the income was taken as an exogenous variable; however, not having been able to obtain improvement in the results, it appeared that the income was not really exogenous. For this reason, the decision was made to separate the agricultural income from the total income and include it as an endogenous variable, adding one more equation to the initial system as follows:

$$\begin{aligned} q_c &= f_1 (P_c; P_b; P_w; P_r; I_a; I_{na}) \\ q_b &= f_2 (P_c; P_b; P_w; P_r; I_a; I_{na}) \\ q_w &= f_3 (P_c; P_b; P_w; P_r; I_a; I_{na}) \\ q_r &= f_4 (P_c; P_b; P_w; P_r; I_a; I_{na}) \\ I_a &= f_5 (Q_c; Q_b; Q_w; Q_r; I_{na}) \end{aligned} \qquad (8)$$

where I_a represents agricultural income, the Q's production of the four commodities under study, I_{na} represents non-agricultural income and I_{ns} is a non-subsistence crop production index.

The new system of equations in (8) still remains "just identified". However, the agricultural income equation can be calculated separately from the system and later inclue its predicted values in the system of four equations. With this new model it is possible to calculate an approximation of the income elasticities for the urban and rural sectors separately. The decision to include the predicted agricultural income as it appears in the model is justified by the following specification:

$$I_a = I_p + S + R \qquad (9)$$

in which I_a represents the agricultural product, I_p, the product generated by the agricultural production, S represents wages and salaries and R, the

rents. Performing several algebraic manipulations under the assumption that the relation between I_p and P (agricultural production) is constant, it follows that

$$I_a = P\left(\frac{I_p}{p}\right) + S + R \qquad (10)$$

Obtaining the total differential of (10), dividing both sides of the equation by I_a, then multiplying and dividing the second member terms respectively by S, P and R it takes the form:

$$\frac{dI_a}{I_a} = \frac{dP}{P}\left(\frac{I_p}{I_a}\right) + \frac{dS}{S}\left(\frac{S}{I_a}\right) + \frac{dR}{R}\left(\frac{R}{I_a}\right) \qquad (11)$$

where

$$\frac{dP}{P} = \sum_{i=1}^{n} \alpha_i \left(\frac{dP_i}{P_i}\right)$$

substituting this value in expression (11), the result is as shown in (12).

$$\frac{dI_a}{I_a} = \sum_{i=1}^{n} \alpha_i \frac{dP_i}{P_i}\left(\frac{I_p}{I_a}\right) + \frac{dS}{S}\left(\frac{S}{I_a}\right) + \frac{dR}{R}\left(\frac{R}{I_a}\right) \qquad (12)$$

Taking anti-logarithms from both members of (12), the following equation is derived:

$$I_a = \left(\prod_i P_i^{\alpha_i}\right) I_p/I_a \; S/I_a \; R/I_a \qquad (13)$$

which expresses agricultural product as a function of aggregated agricultural production, S and R.

For the lack of data on S and R, I_a was estimated only as a function of the production for the four basic commodities under study and an index of production which includes cotton, tomato, coffee and sugar cane. The estimated equation took the following form:

$$\log I_a = \log \alpha_o + \alpha_c \log Q_c + \ldots + \alpha_r \log Q_r + \alpha_{ns} \log I_{ns} \quad (14)$$

in which $\Sigma \alpha_i = \alpha_i \left(\frac{I_p}{I_a}\right)$ and $\alpha_o = \dot{S}\left(\frac{S}{I_a}\right) + \dot{R}\left(\frac{R}{I_a}\right)$

(the dot above the variables indicates their rate of percentage change)

The result of the estimate of equation (14) is the following:

$$\Sigma \alpha_i = 0.93 \quad \text{and} \quad \alpha_o = 1.33$$

Assuming that the sum of the elasticities in (13) is unitary it follows that:

$\frac{S}{I_a} + \frac{R}{I_a} = 0.07$; in other words, that specification (14) explains 93% of the agricultural product generated by the production.

1. Variables

In an analysis of this kind, it is necessary to divide the variables in two groups: (1) those which are determined simultaneously in a system of equations of the model called "endogenous variables" and (2) those which affect the endogenous variables but which are not affected by them directly, that is, which are determined by factors external to the system, called "predetermined variables".[12]

a. Endogenous variables The following variables are supposed to have been jointly determined by the same set of economic factors during the years included in the analysis:

P_c = Average weighted price of corn in pesos per ton.

P_b = Weighted average price of beans in pesos per ton.

---

[12] The predetermined variables also include lagged values of the endogenous variables.

P_w = Weighted average price of wheat in pesos per ton.

P_r = Weighted average price of rice in pesos per ton.

I_a = Agricultural product in millions of 1950 pesos.

b. Predetermined variables The following variables are believed to have influenced the values of the endogenous variables during the years included in the study, but not to have been affected by them to a significant degree during any marketing year.

q_c = Apparent consumption of corn in thousands of tons.

q_b = Apparent consumption of beans in thousands of tons.

q_w = Apparent consumption of wheat in thousands of tons.

q_r = Apparent consumption of rice in thousands of tons.

L_a = Rural population in thousands of inhabitants.

L_{na} = Urban population in thousands of inhabitants.

L_t = Total population in thousands of inhabitants.

I_t = Total gross domestic product at 1950 prices (millions of pesos).

I_{na} = Total gross domestic product minus the generated product in agriculture at 1950 prices (millions of pesos).

To determine the agricultural domestic product, the following predetermined variables were used:

Q_c = Corn production in thousands of tons.

Q_b = Bean production in thousands of tons.

Q_w = Wheat production in thousands of tons.

Q_r = Rice production in thousands of tons.

I_{ns} = Production index of four non-subsistence crops, weighted with 1960 rural prices.

For all the variables included in the specification of the Agricultural Product, corrected data were used because the estimates made with the DGEA data were not very specific. The production index was elaborated with the corrected production of cotton, tomato, coffee and sugar cane.

2. Period of study

One of the serious problems with studies of this kind is that of obtaining sufficient years in which the structural conditions of the economy are assumed to be homogeneous. Of course such a situation is almost impossible in a country in the process of development such as Mexico, and in which marked structural changes have taken place. However, due to requirements of a statistical nature, more statistical significance is attached to the results of the estimates as a greater number of years are included. Therefore, two different periods were used to adjust the model, one which includes the 1930-65 period and the other the 1940-65 period, having 29 and 19 "degrees of freedom", taking into account that the number of variables is seven.

B. Statistical Information

There is a general belief among investigators that the statistical information which exists in Mexico is limited, incomplete and of doubtful validity. This point of view has been an obstacle for the development of economic investigation. The investigator who tries to carry out a thorough analysis of the behavior of some economic phenomena generally runs into difficulties on discrepancy between the reported data by

different sources, so that he decides to restrict the work to the general aspects, concluding that no appropriate information exists. In many cases, it must be accepted that first quality data are not to be found; however, even with such limitations, it is possible to do a great deal with the available information or at least it should be used to prove it really is useless. On the other hand, with the help of a few adjustment procedures, it is possible to correct the actual information, while a restructurization is made on how and what type of information the institutions in charge will need to collect. Meanwhile, studies will have to be carried out which even with margins of error will give closer estimates of the behavior of the different economic and social phenomena of Mexico.

Following is presented a brief discussion on the data used in the present study.

1. Production

With respect to the production data, these are reported principally by two official sources. The DGEA and the Agricultural Livestock Census. Both sources report area cultivated, yield average per hectare, production, rural price and value of production estimates. The DGEA reports these data annually while the Census only every ten years.

a. Discrepancies between the two sources By comparing the reported estimates by both sources by the years 1930, 1940, 1950 and 1960, it is possible to observe that these differ considerably (see Table 8). In the case of corn, beans and rice, the DGEA estimates are inferior to those reported by the Census, and in the case of wheat, the opposite occurs.

Table 8. Discrepancies between the DGEA, production data and the Census[a,b]
(thousands of tons)

Year	Corn			Beans			Wheat			Rice		
	Census	DGEA	%	Census	DGEA	%	Census	DGEA	%	Census	DGEA	%
1930	1,991	1,377	30.8	87	83	4	276	370	25.4	68	51	25.0
1940	3,080	1,640	46.8	161	97	39.8	414	464	10.7	120	73	39.1
1950	4,850	3,122	35.6	371	250	32.6	518	587	11.7	170	123	27.6
1960	5,706	5,386	5.5	661	528	20.1	1,135	1,190	4.6	240	216	5.6

[a]Census data without adjustment to the calendar year.

[b]Source: Censo Agricola Ganadero (Agricultural Livestock Census), SIC, DGEA, SAG. Secretariat of Industry and Commerce and General Bureau of Agricultural Economics, Secretariat of Agriculture and Livestock.

The DGEA obtains the information from several of its branches located in the interior of the country; but principally from reports which it solicits from municipal authorities. The information is also completed with data reported by other agencies; for instance, the Irrigation Districts, the official banks of agricultural credit and agencies of the Ministry of Agriculture.

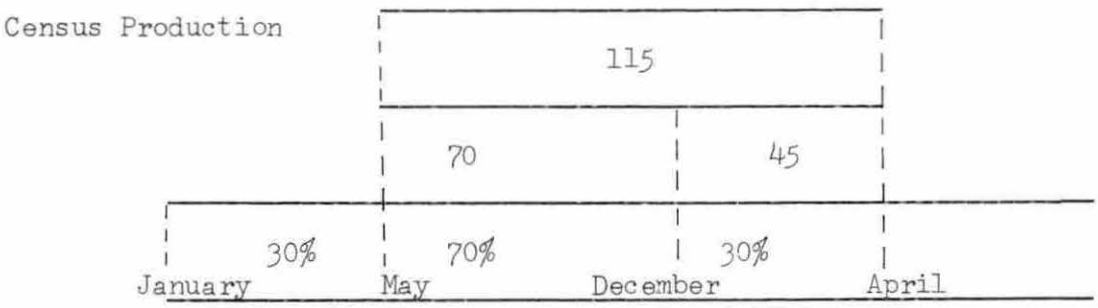
The data given out by the county chiefs are based on a DGEA questionnaire. In the majority of cases, these municipal authorities are not farmers and if they are, they do not fill out the questionnaires. In general, another person is assigned to the job. For this reason, errors of omission from such reports can be expected, such as: (a) they do not frequently include nor give much importance to the non-commercial farms, (b) they give little weight to the ejido farms and (c) the data of the farms located in places with bad communications are not included. On the other hand, neither is the area under double cultivation included in the area reported. A third source of error consists in the "manipulation" of the information when it is not reported to the central office and that the only basis to estimate the missing data is to compare it with reported data for other countries, the agricultural situation for the previous year and the reporting year. According to the above, it can be concluded that the data from the DGEA contains trend errors whether it be of time or of space and errors of omission. Due to the fact that the Agricultural Census derives its information estimates at the farm level and that it is the rural teachers, ejido authorities and trained personnel of the Census Department who obtain this information, it is to be expected that these data are more reliable.

However, observing these data, it is possible to see that the Census information as well as the DGEA are approaching each other, which suggests that at present the estimates are more precise than in the past.

b. Adjustment of data Under the assumption that the reported Census data are more precise, these were used as a bench mark to adjust the annual series of the DGEA.

The comparison made in Table 8 is not congruent since both sources include different years in the collection of data. The DGEA utilizes the calendar year (January-December) whereas the Census includes the year from May 1 to April 30 of the reporting year. For this reason, in Table 9, Census data are presented adjusted to the calendar year. The procedure is the following.

Suppose that the DGEA reports 100 thousand tons of beans for January-December of 1959 and 150 thousand tons for January-December of 1960; considering that the Census year is from May 1959 to April 1960 and that production from May to December represents 70% of the total harvest from January to December of the same year, then the production corresponding to the Census year would be 70% x 100 + 30% x 150 = 115 thousand tons. Then, to adjust these 115 thousand tons to the calendar year, 70% of 115 = 80.5 would have to be taken, adding 30% of 115 x $\frac{100}{150}$ whose value is 23; the result of this adjustment would be 103.5 thousand tons. The latter procedure stems from the assumption that the production reported for the Census as well as that reported by the DGEA would be the same. For greater facility, the following is a generalization of the procedure:



In agreement with the previous graph:

$$P^{c}_{aj \cdot t-1} = \alpha(C_t) + \frac{(1-\alpha)(C_t)}{D_t/D_{t-1}}$$

$$P^{c}_{aj \cdot t-1} = \alpha(C_t) + \frac{(1-\alpha)(C_t D_{t-1})}{D_t}$$

where:

$P^{c}_{aj \cdot t-1}$ = Census production adjusted to the calendar year, in year $t-1$.

α = Percentage of the total production of the crop harvested under consideration from May to December.[13]

C_t = Production reported by the Census.

D_t = Production reported by the DGEA for the reporting year of the Census.

D_{t-1} = DGEA production for the year previous to the reporting year.

---

[13] The values of α used for the adjustment were facilitated by Dr. Reed Hertford, EDB, ERS, USDA, INIA/SAG Mexican Productivity Study.

Table 9. Discrepancies between DGEA production data and the Census[a, b]
(thousands of tons)

Year	Corn			Beans			Wheat			Rice		
	Census	DGEA	%	Census	DGEA	%	Census	DGEA	%	Census	DGEA	%
1930	2,009	1,469	26.9	88	95	.07	276	367	24.8	70	44	42.8
1940	3,165	1,977	37.5	170	148	12.9	408	429	4.9	120	70	41.7
1950	4,919	2,870	41.7	368	231	37.2	504	503	0.0	170	122	29.2
1960	5,622	5,563	0.1	668	581	13.0	1,147	1,337	14.2	203	172	15.3

[a]The data of the Census were adjusted to the calendar year (see procedure in the text).

[b]Source: Censo Agricola y Ganadero, SIC and the DGEA, SAG.

With the above procedure, the Census production data of the commodities under study were adjusted to the calendar year. The adjusted series are presented in Table 9.

Even with the above mentioned adjustments to the Census data, some discrepancies still remain. However, now the Census data corresponds to the calendar year for the four Census year, therefore it is possible to adjust the DGEA annual series by means of interpolation, using the Census data as bench marks.

The purpose of the interpolation is to adjust the DGEA in such a way as to make the annual variation of the DGEA fall on the corresponding line of the Census data, as shown in Figure 3.

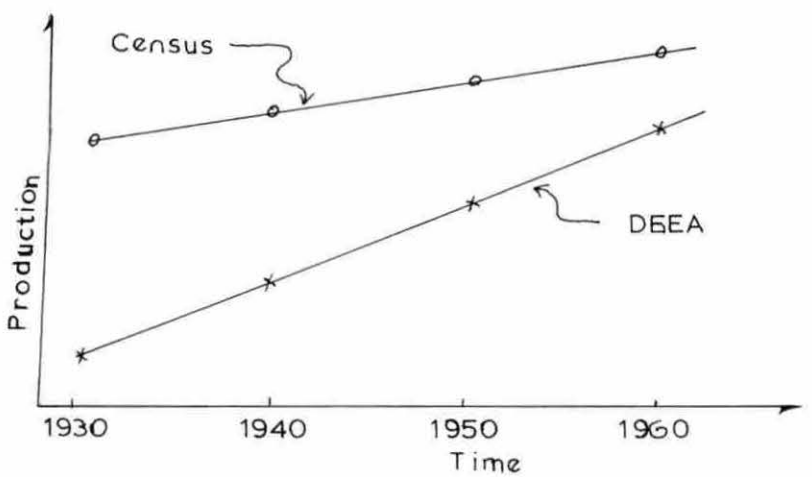


Figure 3. Hypothetical discrepancies between the DGEA production data and the census

Given two Census observations and two of the DGEA with a lapse of ten years, the following formula is applied:

$$C_t - D_t = \alpha_o \qquad (1)$$

$$C_{t+10} + -D_{t+10} = \alpha_o + \beta_{10} \qquad (2)$$

$$\beta = \frac{(C_{t+10} - D_{t+10}) - (C_t - D_t)}{10} \qquad (3)$$

$$P_t = \alpha_o + \beta T + D_t \qquad (4)$$

where

C = Census figure.

D = DGEA figure.

α_o = Difference between the Census figure and the DGEA figure in year "t".

β = Relation with respect to year t = (1, 2, 3, ..., 10) which will equal C_t and D_t.

The production data were adjusted with the formula (4) and the resulting series were called "adjusted data".

2. Consumption

The estimation of apparent consumption of agricultural products in Mexico have traditionally been made by adding production to imports and subtracting exports. The resulting estimate cannot be considered adequate since the fluctuations which it reflects are not precisely those of consumption but of variations in the production or foreign trade. So, for example, the estimate of the apparent consumption of wheat for 1931 reported by the DGEA apparently was quite high, but this was due mainly to high production in that year; moreover, many imports were made which undoubtedly caused surpluses for the 4 to 5 following years.

The principal reason for this problem is that the inventories were not taken into account. This is one of the strongest obstacles which the investigator confronts in attempting to make studies on demand for agricultural products.

In attempting to correct the consumption series, efforts were made to gather information on inventory records; however, these were not officially recorded until 1954. As the period included in the present study is from 1930 to 1965, it is impossible to adjust the consumption series. Therefore, consumption plus the change in inventories will be used.

3. Prices

Data on prices are collected and reported by the DGEA, the General Bureau of Statistics and the Secretariat of Industry and Commerce. There exist average rural price data for the Republic, and wholesale and retail prices for nine principal Mexican cities. These last two series are reported as monthly and annual single averages.

For the purpose of the study, average prices for the whole Republic were required, but since they were not reported this way, it was necessary to calculate national series of wholesale prices. In order to do this, prices of the nine principal cities were taken and a national average was calculated. This average was weighted with population of each of these cities, since data did not exist on the quantity consumed in these cities. However, the assumption that the number of consumers can represent an index of quantity consumed is valid. Once the weighted average was obtained, the attempt was made to compare it with a single price average (Figure 4). The result did not reveal a great difference between the

fluctuations of one with respect to the other. In accord with the latter, it is possible to think that there exist no regional differences in connection with price movement. Therefore, a regional analysis would be unnecessary considering the country as a national market in the sense that price movements are transmitted in all parts in equal proportion.[14]

---

[14] Suppose that the price series obtained using a single average is as follows:

$P^{o}_{t} = W_{10}P_{1t} + W_{20}P_{2t} + \ldots + W_{90}P_{9t}$ where t-year (1, 2, 3, ..., 36),

$W_{10} = W_{20} = \ldots = W_{90} = \frac{1}{9}$ = weight value and P_{it} = price in city i.

The price series weighted takes the following form:

$$P^{n}_{t} = W^{*}_{10}P_{1t} + W^{*}_{20}P_{2t} + \ldots + W^{*}_{90}P_{9t}$$

where: $(W^{*}_{10} = 1 - (W^{*}_{20} + \ldots + W^{*}_{10})$

Under what conditions is $\dot{P}^{o} = \dot{P}^{n}$ true, defining $\dot{P}$ as the percentage rate of change in prices? That is, under what circumstances is the following true:

$$\dot{P}_{1t}(W_{10} - W^{*}_{10}) + \dot{P}_{2t}(W_{20} - W^{*}) + \ldots + \dot{P}_{9t}(W_{90} - W^{*}_{90}) \equiv 0$$

The above identity will only be true "if and only if" there is <u>linear dependency</u> between vectors.

The necessary condition is fulfilled since the high correlation between $\dot{P}^{o}$ and $\dot{P}^{n}$ implies that the prices in all cities have the same movements. Therefore, using any weighting procedure, it will be found that the resulting index will have the same percentage of change, that is, that $I^{o}_{p} = I^{n}_{p}$.

Table 10. Wholesale prices, weighted averages[a,b] (pesos per ton) 1930-65

Year	Corn	Beans	Wheat	Rice
1930	177	267	144	249
31	86	222	120	264
32	62	180	125	214
33	78	106	160	209
34	67	77	176	239
1935	75	103	149	286
36	95	143	136	260
37	143	218	205	270
38	141	310	224	297
39	134	286	211	327
1940	116	231	216	339
41	123	234	220	331
42	136	250	217	404
43	192	257	265	455
44	335	391	330	646
1945	318	558	349	853
46	459	840	519	1,140
47	400	1,183	543	1,178
48	401	1,059	537	1,152
49	374	897	545	1,159
1950	478	842	680	1,313
51	710	1,290	839	1,701
52	639	1,736	863	1,912
53	570	1,478	813	2,012
54	571	1,462	890	2,258
1955	609	1,533	1,029	2,344
56	730	1,406	1,060	2,414
57	944	1,530	1,066	2,407
58	870	2,232	1,156	2,457
59	747	1,979	1,071	2,402
1960	810	2,189	1,073	2,682
61	864	2,117	1,100	2,876
62	887	2,015	1,087	2,833
63	919	2,293	1,171	2,851
64	977	2,117	1,089	2,710
1965	1,040	2,332	1,095	2,710

[a]Calculated according to procedure described in the text.

[b]Source: The original data came from Anuario Estadistico de los Estados Unidos Mexicanos (several), SIC, Mexico.

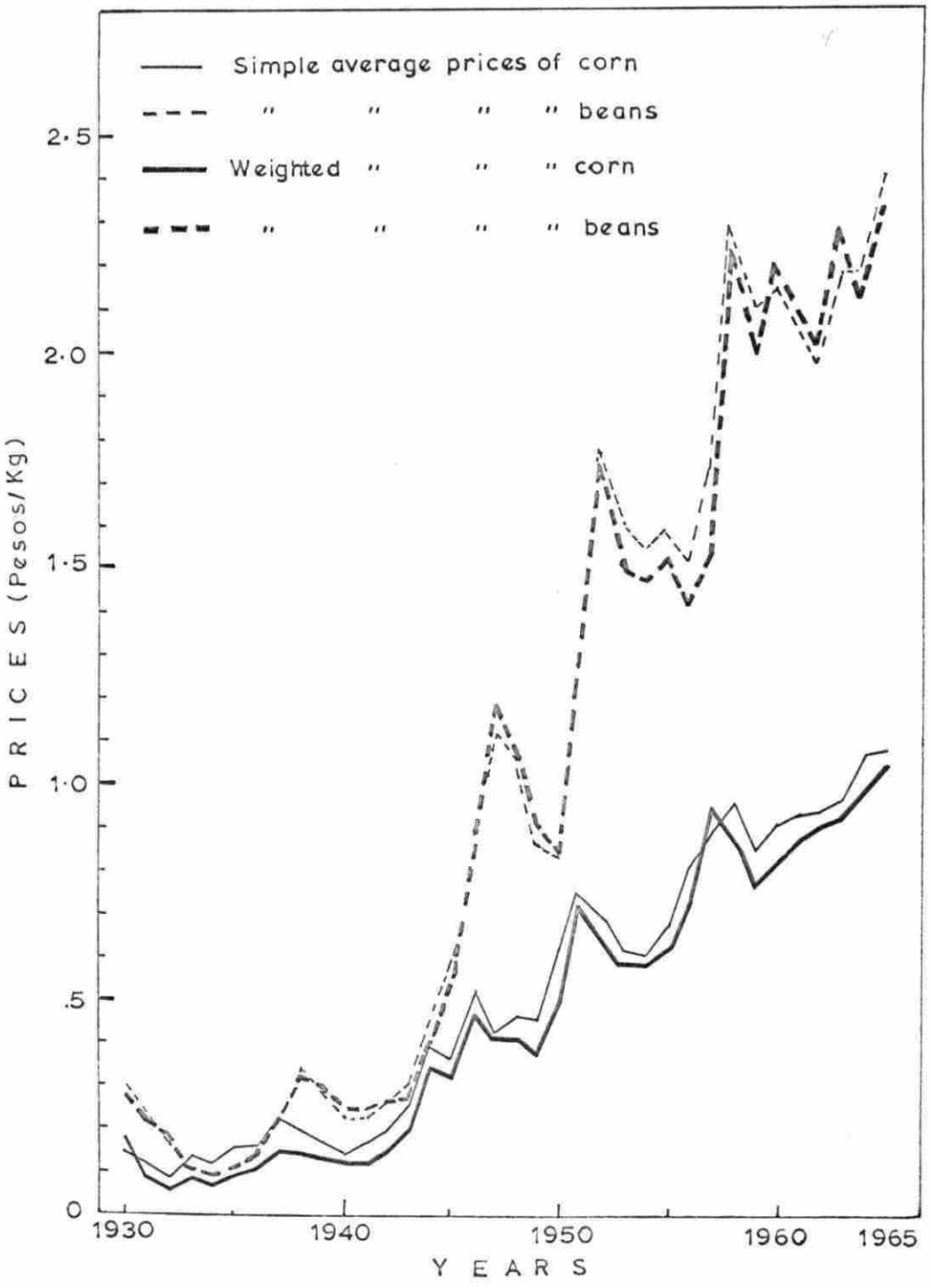


Figure 4. Annual fluctuations of average wholesale prices of corn and beans; two weighting procedures, 1930-65

4. Population

With respect to the population data, Census estimates for each ten year period are relied upon, as well as estimates of the natural rate of growth (which is the difference between birth rate and death rate). Of course, there exist annual estimates calculated by interpolation of compounded interest formulas or linear estimates, but these do not reflect the real annual fluctuations.

For this reason, it was necessary to calculate a series for the 1930-1965 period, taking the Census data and the natural rate of population growth as bench marks. However, the estimated series differ from those of the Census except for the base year. Therefore, the resulting series was adjusted with the same procedure as that used for the production data i.e., using the following formula:

$$P_{ft} = (P^c_t - P^e_t) + \frac{(P^c_{t+10} - P^e_{t+10}) - (P^c_t - P^e_t)}{10} + P^e_t$$

where

t = time (1, 2, 3, ..., 10).

P_{ft} = Definitive population in the year t.

P^c = Census population.

P^e = Estimated population (intermediate series).

The problem with the rural population is even more difficult since no collateral information exists, as it does in the case of the total population; however, for the present study it was necessary to rely on annual estimates, so that it was decided to adjust a polynomial equation to the four points given for the Census estimates. The Census estimates appear in graphic form as shown below in Figure 5.

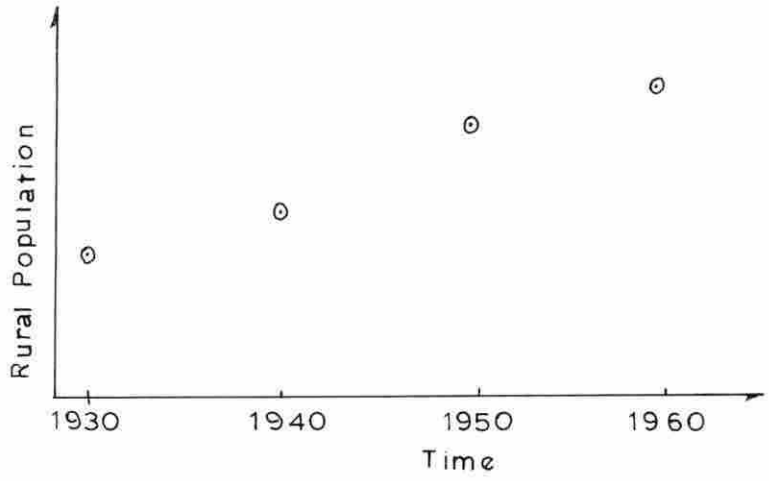


Figure 5. Hypothetical trend in rural population for four census years

The polynomial equation takes the following form: $P_r = A$ in which P is a column vector (4x1), A is a matrix (4x3) and is a column vector of (4x1). In matrix A, the element $a_{11} = a_{12} = a_{13} = 0$; $a_{21} = 10$, $a_{22} = a_{21}^2$, $a_{23} = a_{21}^3$; $a_{31} = 20$, $a_{32} = a_{31}^2$, $a_{33} = a_{31}^3$ and $a_{41} = 30$; $a_{42} = a_{41}^2$, $a_{43} = a_{41}^3$. Since 1j vector is lineally dependent, Matrix A is reduced to a (3x3), the vector β to (3x1) and vector P to (3x1). To estimate the β_i parameters, it follows that $\hat{\beta} = A^{-1}P$ so that

$$A^{-1}P = \begin{bmatrix} 160,985.00 \\ 1,295.00 \\ 9.04 \end{bmatrix} = \hat{\beta}$$

The resulting computed polynomial equation is as follows:

$$P_t = 11,012,091 + 160,985t + 1259t^2 + 9.04t^3$$

with which annual rural population was calculated taking 1930 as a base year. For total and rural population see Tables 28 and 29 in the Appendix.

5. Income

With respect to statistics on aggregated income, only annual estimates of the Gross National Product exist, which the Bank of Mexico, S.A. elaborates by legal decree. The published estimates of the GNP are reported in total terms, therefore no estimates of the disposal income exist; however, for purposes of the present study, the GNP can be used as a variable in the level of income for each of the years included in the study.

In order to make estimates of the Gross Domestic Product, the Department of Economic Studies of the Bank of Mexico utilizes as base an input-output matrix (elaborated with Census data and collateral information whether it be official, private, or by means of surveys) as a base of the level of output for the year under consideration. The input-output matrix is also used for weighting the components of the following years.

In 1945, the Department of Economic Studies of the Bank of Mexico initiated the first studies on the revision and calculation of the GNP. In 1947, as a request from the International Bank for Reconstruction and Development (IBRD), a provisional estimate of national income was carried out at factor cost for the years 1939 and 1945.[15] The figures obtained together with the variation of the volume of production index of goods and services as well as variations in the combined wholesale and retail price index, were used to estimate the total income for the intermediate years and the following years, i.e., for the 1946-1950 period.

---

[15]The Economic Development of Mexico, report of the Combined Mexican Working Party, (Baltimore: John Hopkins Press, 1953).

Afterwards, the Bank of Mexico as well as national and international institutions have continued making estimates separately or together arriving at results with only small discrepancies.

In 1955, taking into account the experience of other countries who used new measuring tools, the Bank of Mexico decided to elaborate an input-output matrix (principally with 1950 Census data) which would serve as a starting point to base the elaboration of a national account system, as well as to determine the structure of intersectoral relationships. The studies carried out were supervised by an expert of the United Nations Organization, Mr. Cornelius A. Oomens.

The result of the elaboration of the input-output matrix was a system of national accounts for 1950. These results were published in a study entitled, "Estructura y Proyeccion de la Economia de Mexico 1950, 1960, 1965." On the other hand, the Department of Industrial Studies of the Bank of Mexico carried out a study based on the input-output matrix, improving and supplementing in what is referred to as manufacture industry.

The levels achieved for the GNP and National Income figures within the national account system derived from the 1950 input-output matrix, were 9 percent lower than the figures for the same year obtained by the Mexican Working Party; however, the difference is mainly due to the income generated in the retail as well as the wholesale market. This calculation was made with little statistical information.

As a general conclusion, it can be affirmed that the estimates of the Gross National Product in Mexico, although they suffer from precise details, can be accepted as a panoramic reflection of the growth and fluctuations of the National Product. On the other hand, even in the more

developed countries, with the techniques and facilities for estimation, with more detailed and precise statistics, there still exist margins of error and omissions.

Recently, a new input-output matrix was formulated with 1960 Census data. The Bank of Mexico has realized an adjustment to the annual estimates based on the 1950 input-output matrix. These revisions have been published in preliminary form (see Table 11).[16]

Published estimates of the total GNP exist from 1900 to 1910 and from 1921 to 1931 for six principal sectors; on the other hand, there are estimates of the Mexican Working Party for 1940-1949[15] and those of the Bank of Mexico for 1950-1965. The estimates of the Mexican Working Party as well as those of the Bank of Mexico refer to the Gross Domestic Product. For this reason, the Gross National Product for the 1930-1939 period was adjusted. Since no information exists on net international transfers of wages and salaries for 1930-1939, the adjustment was made applying a proportion (λ)[17] to the GNP data for those years. The GNP generated in the agricultural sector followed the same procedure.

---

[16] Bank of Mexico, S.A. Department of Economic Studies, Informe sobre la revision preliminar de las estimaciones del producto nacional bruto de 1950 a 1962. Comercio Exterior. September 1963, Mexico.

[17] $$\lambda = \frac{\text{Gross Domestic Product of 1939}}{\text{Gross National Product 1939}}$$

$$\lambda = \frac{\text{GDP 1939}}{\text{GNP 1939}} = \frac{1915}{20505} = 0.9339$$

Table 11. Annual Gross Domestic Product,[a,b] 1930-65
(millions of 1950 pesos)

Year	Agricultural	Non-agricultural	Total	Per capita[c] (pesos)
1930	2,203	12,308	14,512	877
31	2,914	12,128	15,042	895
32	2,587	10,016	12,603	741
33	2,861	12,014	14,875	860
34	2,536	13,378	15,914	904
1935	2,676	13,238	16,164	902
36	2,926	14,341	17,267	947
37	2,819	15,038	17,857	1,016
38	2,914	15,273	18,187	962
39	3,264	15,887	19,151	993
1940	2,993	16,465	19,458	990
41	3,515	18,468	21,983	1,092
42	4,034	20,996	25,030	1,213
43	3,697	22,405	26,102	1,234
44	4,041	24,434	28,475	1,312
1945	3,917	26,898	30,825	1,382
46	4,057	28,976	33,033	1,443
47	4,432	29,196	33,628	1,424
48	4,945	30,387	35,332	1,453
49	5,167	31,869	37,036	1,480
1950	5,999	35,061	41,060	1,592
51	6,299	37,918	44,217	1,676
52	6,017	39,922	45,939	1,701
53	6,053	39,976	46,029	1,650
54	7,571	43,288	50,859	1,789
1955	8,417	46,895	55,312	1,891
56	7,931	51,031	58,962	1,954
57	8,669	54,762	63,431	2,039
58	9,430	57,488	66,918	2,089
59	8,711	60,141	68,852	2,081
1960	9,178	65,139	74,317	2,128
61	9,417	67,510	76,927	2,128
62	10,013	70,729	80,742	2,158
63	10,163	75,702	85,865	2,218
64	10,986	83,629	94,615	2,358
1965	11,316	88,186	99,502	2,393

[a]Source: 1930-40. Perez Lopez, Enrique, "El producto national", Cincuenta Anos de Revolucion. (Mexico: Fondo de Cultura Economica, 1960), pp. 511-580; 1940-49; Economic Development of Mexico, Report of the Combined Mexican Party, Baltimore: The John Hopkins Press, 1953). Table V. 1950-65: Bank of Mexico, S.A. Department of Economic Studies Mimeograph of Sept. 2, 1963. For the last three years, Bank of Mexico, S.A.

[b]1930-39 data were adjusted according to the procedure described in the text.

[c]Calculated with the population series of Table 12.

C. Results

In this part of the work, results and discussion of the different attempts to adjust the model are presented. In earlier attempts both series on consumption, that of the DGEA and that of the adjusted series, were used.

The first attempt before using the complete model was to use the consumption series, income and population in total terms in both the single and simultaneous equation models. The resulting estimates were meaningless, mainly because of the high degree of correlation among the independent variables. Later, consumption and income were included in per capita terms but the results did not improve.

The second step consisted in the use of the models as presented in Part II-A in which, in order to estimate the income elasticity for the rural and urban sectors, an artificial variable representing rural income was included. The resulting estimates are shown in Tables 12 and 13.

As it can be observed, serious inconsistencies exist in the four groups of results concerning signs as well as the absolute values of the estimated parameters. The price elasticities came out with correct signs in the case of the estimation with the simultaneous model and in which DGEA data on consumption were used. The cross elasticities resulted with non-corresponding signs. On the other hand, income elasticities came out with opposing signs as well as high absolute values. In most of the estimated parameters, the statistical significance was low in both the single equation model and the "reduced form" of the simultaneous equation models. For the latter, see the "reduced form" in Table 34 in the Appendix.

Table 12. Single equation estimates using DGEA data

Consumption	R^2	Constant Term	P_m	P_f	P_t	P_a	I'	I	P_p
q_m	0.79	0.5577	-0.3187 (0.2036)*	+0.1131 (0.1161)*	-0.0345 (0.2156)*	+0.1778 (0.2318)*	-0.8392 (0.7639)*	+1.3179 (0.4869)*	-0.0086 (0.2766)*
q_f	0.86	1.1938	-0.6934 (0.2449)*	+0.1362 (0.1458)*	+0.1716 (0.2718)*	+0.1467 (0.2526)*	-1.6605 (0.9718)*	+2.8438 (0.5963)*	
q_t	0.76	-3.0584	+0.2418 (0.1983)*	+0.0592 (0.1181)*	-0.5009 (0.2201)*	+0.0375 (0.2046)*	+1.0149 (0.7840)*	+0.2567 (0.4829)*	
q_a	0.71	-2.7801	-0.1067 (0.2875)*	+0.2460 (0.1703)*	+0.0694 (0.3191)*	-0.1048 (0.2966)*	-0.247 (1.4088)*	+0.5246 (0.6998)*	
					Corrected Data				
q_m	0.55	-4.7706	-0.1063 (0.1553)*	+0.0454 (0.0886)*	+0.0504 (0.1645)*	+0.0838 (0.1645)*	+2.0705 (0.5827)*	-1.8368 (0.3715)*	+0.1437 (0.2110)*
q_f	0.89	-3.6583	-0.4526 (0.2277)*	+0.0736 (0.1356)*	+0.1677 (0.2527)*	+0.3071 (0.2349)*	+0.6399 (0.9037)*	+0.5444 (0.5544)*	
q_t	0.72	-5.7523	+0.3448 (0.2250)*	+0.0405 (0.1340)*	-0.4348 (0.2497)*	-0.0346 (0.2321)*	+2.3997 (0.8929)*	-0.8718 (0.5478)*	
q_a	0.37	-4.3219	-0.0242 (0.1901)*	+0.1262 (0.1132)*	+0.1374 (0.2110)*	-0.2000 (0.1961)*	+1.0752 (0.7544)*	-0.5280 (0.4629)*	

*Note: The numbers in parenthesis are the standard errors of the regression coefficients.

Table 13. Simultaneous estimates using DGEA data*

Consumption	R^2	Constant Term	P_c	P_b	P_w	P_r	I'	I
q_m	0.99	A_1	-1.2763	+0.4102	-2.7937	+3.3910	+0.3808	+2.1849
q_f	0.96	A_2	-2.2270	-0.1242	-2.5776	+2.7579	+0.0123	+2.9860
q_t	0.98	A_3	-0.4149	+0.6305	-3.0415	+0.7994	+2.9344	+1.2480
q_a	0.99	A_4	-2.1249	+3.3744	+2.8123	-6.1469	+7.7687	+0.3035
				Corrected Data				
q_m	0.99	A_1	-3.4302	+3.5639	-1.9272	+0.0002	+11.7720	-0.7545
q_f	0.96	A_2	-4.4649	+3.2480	-2.0765	+0.0001	+10.9264	+0.9869
q_t	0.99	A_3	-2.9417	+3.7599	-4.1581	+0.0001	+12.3566	+1.0799
q_a	0.99	A_4	-0.0000	+0.0000	+0.0001	-0.0002	+0.0002	-0.0001

*Note: See Appendix for the "reduced form". The constant term was not calculated.

The main reason for the poor estimates is once again the high degree of correlation among the independent variables.

After the above alternatives were performed without any improvement in the results and after a careful examination of such results, it appears that the principal problem lay with the income variable. Therefore, the artificial variable used to represent rural income was substituted by the national domestic product generated in the agricultural sector and the national domestic product generated in the other sectors was included to represent non-agricultural income. The estimates obtained with the above modifications of the income variables came out worse, especially those estimates for the income elasticities.

Up until this time, the possibility was considered that an error was committed by including agricultural income, as an "exogenous" variable. The reason for this is that most of the agricultural domestic product is generated by the production of the four commodities under study. Under this assumption, one equation had to be included in the system in order to include the agricultural income as an "endogenous" variable. Since the new equation included (as it was explained in Part II-A) only one endogenous variable, this equation was calculated directly by least squares. The predicted values of the agricultural income were then included in order to compute the entire system. The results obtained with the latter formulation are shown in Table 14.

Due to the poor estimates from the single equation model as well as those in which the DGEA data were used, the results are not shown. In Table 15, the results obtained using adjusted data as above but including the 1940-1965 period are shown.

Table 14. Simultaneous estimates[a] and structural equations[b] using adjusted data, 1930-1965

Quantity / Prices	P_m	P_f	P_t	P_a	I_a	I_{na}
q_c	-0.7216	0.6864	-1.6653	1.3552	-0.5352	0.8103
q_f	0.0695	-0.0694	0.0230	-0.1217	-0.1312	-0.1744
q_t	-0.2512	0.4308	-1.1731	0.8214	-0.3758	-0.4105
q_a	0.1252	-0.0108	0.6227	-0.6192	0.0973	-0.1295

[a]Estimates in which the predicted values of agricultural income were used.

[b]See the "reduced form" in Table 35 in the Appendix.

Table 15. Simultaneous estimates[a] and structural equations[b] using adjusted data, 1940-1965

Quantity / Prices	P_m	P_f	P_t	P_a	I_a	I_{na}
q_c	-2.7224	-11.7932	-3.2366	1.9138	-2.0551	-4.1303
q_f	-0.2126	-2.6663	-2.1358	5.5952	-0.4346	-1.1207
q_t	-0.3744-	-6.9518	-2.2254	9.9267	-0.8240	-2.7362
q_a	1.6344	9.8750	6.5299	-1.8316	0.8817	3.6238

[a]Estimates in which the predicted values of agricultural income were used.

[b]See the "reduced form" in Table 35 in the Appendix.

As it is possible to observe, the results from both estimates differ in absolute values as well as in signs when the time period was changed. In the results using the 1930-65 period as well as those using the 1940-65 period, the signs of the price elasticities are alike and as they were expected. The signs of the cross elasticities are correspondent one to another (i.e. the sign of the elasticity of the i-th commodity with respect to the price of the j-th commodity is equal to the sign of the elasticity of the j-th commodity with respect to the price of the i-th commodity) except those for corn and wheat in Table 15. With respect to the estimates for the income elasticities, they are lower for the non-agricultural sector than for the agricultural sector except for corn in Table 14 and for rice in Table 15. Due to the improvement in the results gained by including the predicted agricultural income, adjusted data and the 1930-65 period, the possibility of improving the results arose by using the 1940-65 period results under the assumption that during the latter period the annual data would be more reliable. The results, however, showed the contrary (see Tables 14 and 15). The signs of the price elasticities remained as expected but the signs of the cross elasticities changed in opposite directions. On the other hand, the absolute values augmented in most of the parameters. It should be noted that in both estimates the values of the correlation coefficients between the independent variables (reduced form) decreased considerably. These coefficients fluctuated between 0.038 and 0.45 with the exception of the correlation between the agricultural income and quantity of beans in the equation for corn, which was 0.91.

As the problem still appears to be with the income variables, the model was adjusted to include others representing lagged values of the income variables. The above decision was based on one of the formulations used by Modigliani[18] in which he considered that the present consumption is a function of the current and higher income registered in previous years. The Modigliani formulation is a variation of Friedman's Permanent Income Hypothesis.[19]

The results of the estimates lagging the income variables from two up to four years were meaningless, therefore they are not shown.

The last attempt made consisted in estimating the price and cross elasticities of demand, adjusting the consumption series for changes in income. These adjustments were made with the income elasticities of demand estimated by the Office of Agricultural Projections of the Bank of Mexico, S.A. (see Table 1).

As it is possible to see in Table 16, the estimated price elasticities for corn, beans and wheat resulted with positive signs. Only for rice the sign was as expected. The signs of the cross elasticities are correspondent to each other (i.e., the sign of a_{12} is equal to the sign of a_{21}). However, the resulting signs are contrary to those expected.

Up to now, only results of the different attempts and modifications of the model have been presented as well as the reasons by which such

---

[18] Friedman, Milton. A Theory of the Consumption Function. Princeton, 1957. p. 127.

[19] Ibid., p. 129.

Table 16. Corrected data of price and cross elasticities of demand for four commodities[a]

Consumption	P_m	P_f	P_t	P_a
q_m	4.436	-7.293	8.248	-2.994
q_f	-1.067	2.958	-2.987	0.956
q_t	2.983	-0.781	0.611	2.521
q_a	-0.727	2.758	2.148	-4.188

[a]These estimates correspond to the structural form. The estimates were calculated adjusting the consumption series with the income elasticities estimated by the Office of Agricultural Projections of the Bank of Mexico, S.A. (see Table 1).

modifications were performed; however, little has been said about the reasons for which such results have been obtained. The reasons may be numerous, but among them the most important will be discussed as follows.

a. Since the beginning of the analysis, one of the main problems presented was that related with the way in which the apparent consumption of the four commodities was estimated. The apparent consumption estimates, as it has been said before, include only production plus net imports, without taking into account the changes in inventories. The result of these estimates do not reflect the real fluctuations on consumption. In spite of the fact that imports were made to cover the deficits of production, on many occasions imports surpassed the domestic needs causing surpluses for the following years. Therefore, for those years in which the above situation prevails, the apparent consumption figure estimated in the previous described way resulted inflated.

Initially, the analysis was started with these consumption series only in tentative form, with the hope of getting at least inventory figures in the storages of the official credit institutions and in the stored records of the price control agencies. Unfortunately, it was impossible to get such information. This does not mean that such data does not exist, as it must be in the files of the above mentioned agencies; but access to them was impossible due principally to bureaucratic reasons.

It was possible to complete series on total supply and distribution of the four commodities under study which include inventory estimates. This information was supplied by the Office of the Agricultural Attache of the American Embassy. This data is shown in Tables 30, 31, 32 and 33 in the Appendix. The problem of using this data is that it covers only the 1955-65 period and with a different calendar year. The fact is that this information was not available for the whole period in order to adjust the consumption series and remove the above mentioned source of error.

b. In most of the estimates done, the values of the price elasticities appeared to be high. One of the possible reasons could be the effect of the government programs on price control for subsistence agricultural products. If such policy has had an important impact in the marketing of the commodities under study, this implies that the market of these products is not an equilibrium market. Under this situation, price variations due to changes in the quantities demanded are restricted, originating a different shape of the demand curve to that in absence of such control. If the price control operates rigidly, the demand curve would take a horizontal position. Evidently this is not the case, however,

the guaranteed prices (those at which CONASUPO sells) as well as the top prices allowed by the government in the retail market have some effect on demand.

According to the above considerations and the results obtained, it is quite possible that the estimated price elasticities belong to demand curves less inclined than for those corresponding to the demand curves in a freer market. This situation can be shown by the diagram in Figure 6.

In the absence of price control, the equilibrium would reach at point "e" given the demand curve DD and the supply curve "S". With the price control program operating with purchases $\overline{OC}$ at price P_c, and the quantity $\overline{CT}$ moving freely in the market, the equilibrium would be reached at point "t" on the demand curve DD' which is more elastic than the curve DD.

c. Even in the case of solving the above problems, there will still remain those related with the way the income, prices and population figures are estimated; however, the latter could be of less importance.

d. Omission of variables in the model could be another source of distortion in the results. These variables might be very important but difficult to measure, such as tradition and customs, the average age of the consumption unit (family), distribution of population, etc. In the demand of subsistence commodities, social variables could be more important than the economic variables.

e. Finally, there exist methodological problems, those related with statistical or econometric problems as "identification", "multicolinearity" and "serial correlation" which have been difficult to remove.

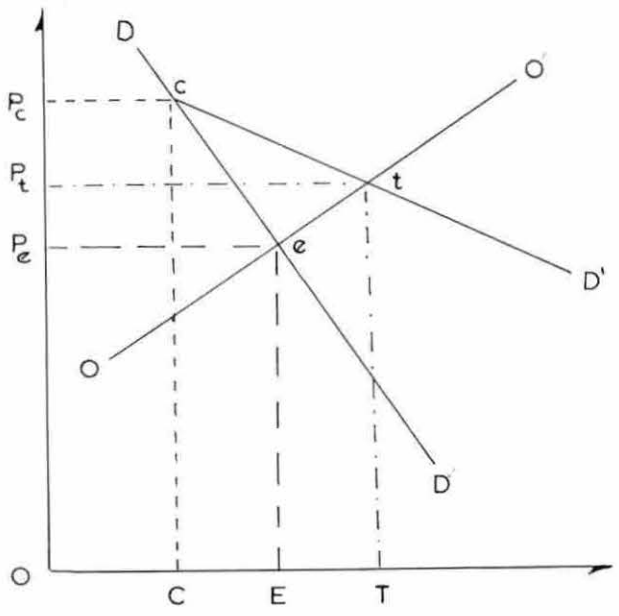


Figure 6. Theoretical equilibrium under the price support program

As a final comment, it has to be said that all the possibilities of obtaining better results using time series data were not exhausted, except for those more accessible. There still exists the possibility of studying the demand of agricultural products by means of cross section data.

There is already cross section information from a survey at a national level carried out in 1963 by the Office of Agricultural Projections and another survey that will soon be finished.

D. Summary and Conclusions

The main purpose of the present study was to know something about the behavior of demand for four subsistence crops (corn, beans, wheat and rice) in Mexico. It was attempted to determine the principal factors that affect the demand for the four commodities and the measurement of their different relationships.

With the above objectives in mind, some theoretical considerations on the principal factors that affect demand were made. Later, two different approaches were followed for the analysis, the single equation approach and the simultaneous equation approach.

The analysis was based on the use of time series data and included the 1930-1965 period. Due to the fact that the statistical information in Mexico is reported mainly by two different agencies, there exist wide discrepancies in most of the reported figures. The reporting agencies are the Agricultural and Livestock Census of the Ministry of Industry and Commerce and the General Bureau of Agricultural Economics of the Ministry of Agriculture and Livestock. Therefore, some adjustments had to be made to the data in order to perform the analysis.

A summary of the different attempts made to fit a model which could explain the different relationships among the factors that affect the demand for the commodities under study is presented below.

(1) The first attempt consisted in including consumption and income in per capita terms using both the DGEA and the adjusted series data. Both the single equation and the simultaneous equation models were used. The results did not show any consistency, as it is possible to see in Tables

12 and 13.

(2) The second step consisted in trying to fit the models as before with the exception that in this case the consumption and income variables were included in total terms instead of in per capita terms. The estimates resulted completely different both in signs and absolute values with low R^2 and low statistical significances. The period of study was changed without any improvement in the results.

(3) In order to estimate the income elasticity for rural and urban sectors, an artificial variable representing rural income was included. The estimates resulted with correct signs for the price elasticities in the simultaneous model in which DGEA data on consumption were used. The cross elasticities resulted with incorrect signs as well as the income parameters. The reason for the poor estimates was the high degree of correlation among the independent variables.

(4) After a careful examination of the results, it appeared that the problem lay with the income variable. Therefore, the gross domestic product generated in agriculture was included to substitute the artificial variable. The results did not improve with this modification.

(5) Up until this time, the possibility was considered that an error was committed by including agricultural income as a predetermined variable since most of the agricultural product is generated by the four commodities under study. After modifying and computing the model, the best results were obtained with the adjusted data, as shown in Table 14.

(6) Due to the improvement in the results gained by including the predicted agricultural income, adjusted data and the 1930-65 period, the

possibility of improving the results arose by using the 1940-65 period. The results, however, showed the contrary.

(7) As the problem still appeared to be with the income variables, the model was adjusted to include others representing lagged values of the income variables. The results of the estimates lagging the income variables from one up to four years were meaningless.

(8) Finally, the last attempt made consisted in estimating price and cross elasticities of demand, adjusting the consumption series for changes in income. The adjustments were made using the income elasticities estimated by the Office of Agricultural Projections of the Bank of Mexico. The results were meaningless.

Due to the above, it can be concluded that the best results obtained are those shown in Tables 14 and 15.

In spite of not fulfilling the main objective of this work, it can be said that the most important contribution of this study is to make evident the difficulty of studying the demand of agricultural products in Mexico with time series data. However, the results of all the different attempts suggest that the price elasticities of the demand for the four commodities studied are somewhat high.

With regard to the estimates of the income elasticities, it was not possible to arrive at any satisfactory conclusion. In most of the attempts made, results in general were such that the rural income elasticities were higher than those for the urban; however, the mixture of signs made it difficult to form a clear picture about the real income elasticities.

Examining Table 7 carefully, the increments of the per capita consumption support the idea that the increase in demand has not been the result of the increment of population alone but of other factors. Therefore, it is possible to accept high values for the price elasticities of demand. If that is the case, negative values for the income elasticities of demand for the commodities under consideration are unexpected.

Finally, it should be noted that the time spent and the cost incurred on this study were great. Therefore, it is suggested that for further study on the demand for agricultural products in Mexico, the analyses by means of cross section data be used rather than analyses by means of time series data.

LITERATURE CITED

1. Banco de Mexico, S.A. Departamento de Estudios Economicos. Informe Sobre la Revision Preliminar de las Estimaciones del Producto Nacional Bruto: 1950-1962. Revista de Comercio Exterior. Septiembre de 1963.

2. Combined Mexican Working Party Report. The Economic Development of Mexico. Baltimore: John Hopkins Press. 1953.

3. Direccion General de Economia Agricola. S.A.G. Consumes Aparentes. 1964.

4. Direccion General de Estadistica. Anuario Estadistico de los Estados Unidos Mexicanos. S.I.C. (several).

5. _____. Censo Agricola Ganadero y Ejidal. 1930, 1940, 1950 y 1960.

6. Flores, Edmundo. Tratado de Economia Agricola. Mexico, D.F. Fondo de Cultura Economica. 1961.

7. Foote, Richard J. Analytical Tools for Studying Demand and Price Structures. U.S. Dept. Agr. Agr. Handbook 146. 1958.

8. Friedman, Milton. A Theory of the Consumption Function. Princeton, N.J. 1957.

9. Fox, Karl A. The Analysis of Demand for Farm Products. U.S. Dept. Agr. Tech. Bul. 1081. 1953.

10. _____. The Measurement of Price Support Cost. J. Farm Econ. 35: 470-478. 1951.

11. Klein, Lawrence R. A Textbook of Econometrics. Evanston, Ill. 1953.

12. Meinken, Kennet W. The Demand and Price Structure for Wheat. U.S. Dept. Agr. Tech. Bul. 1136. 1955.

13. Mexican Ministry of Agriculture, The Economic Research Service, U.S. Dept. Agr., The Bank of Mexico, S.A. and The Mexican Ministry of Finance. Projection of Supply of and Demand for Agricultural Products in Mexico to 1965, 1967 and 1975. Jerusalem. August, 1966.

14. Nacional Financiera, S.A. Mexico en Cifras. 1966.

15. Padilla, Pablo. Elasticidad en la Oferta de la Produccion Agricola. Banco Nacional de Credito Ejidal. Boletin de Estudios Especiales 132. Vol. 11. Julio, 1958.

16. Prais, J.S. and Houthakker, H.S. The Analysis of Family Budget. Cambridge, London, 1965.

17. Schultz, Henry. The Theory and Measurement of Demand. Chicago, Ill. 1958.

18. Schultz, Theodore W. The Economic Organization of Agriculture. New York, N.Y. McGraw Hill Book Co. 1953.

19. Stigler, George J. The Theory of Price. Tenth Printing. New York, N.Y. The Macmillan Co. 1961.

20. Vazquez-Morales, Mateo. Analisis Estadistico de la Demanda de Trigo en Mexico. Unpublished thesis. Chapingo, Mexico, Library, National School of Agriculture. 1963.

21. Wold, Herman and Jureen, Lans. Demand Analysis. Stockholm, Sweden. 1953.

22. Working, Elmer. What do Statistical Demand Curves Show? Quart. Jour. of Econ. 7: 212-255. 1927.

23. Working, Holbrook. The Elasticities of Demand for Wheat. (Abstract) Econometrica 5: 185-186. 1937.

APPENDIX

Table 17. Distribution of total population by age groups in Mexico, 1930-40[a]

Age groups	Population distribution[b] (Thousands of inhabitants)				Average with respect to total population[b]			
	1930	1940	1950	1960	1930	1940	1950	1960
Total	16,553	19.654	25,791	34,923	100.00	100.00	100.00	100.00
0-9	4,803	5,693	7,654	11,094	29.02	28.97	29.64	31.77
10-19	3,370	4,399	5,742	7,893	20.36	22.38	22.26	22.60
20-29	3,038	3,139	4,319	5,452	18.35	15.97	16.75	15.61
30-39	2,154	2,690	2,979	3,973	13.01	13.69	11.55	11.38
40-49	1,442	1,696	2,283	2,595	8.71	8.71	8.63	8.85
50 and over	1,746	2,037	2,823	3,916	10.55	10.36	10.95	11.21

[a]Source: Anuario Estadistico de los Estados Unidos Mexicanos. (Several) S.I.C. Mexico. (S.I.C. - Secretariat of Industry and Commerce).

[b]Calculated with information from the previous source.

Table 18. Geographic distribution of the population by region[a]

Zone	Population distribution[b] (Thousands of inhabitants)				Percentage with respect to total population by regions[b]			
	1930	1940	1950	1960	1930	1940	1950	1960
Mexico	16,553	19,653	25,779[c]	34,923	100.00	100.00	100.00	100.00
Pacific North	975	1,204	1,724	2,613	5.89	6.13	6.69	7.48
North	3,133	3,903	5,177	6,866	18.93	19.86	20.08	19.66
Center	8,044	9,430	12,449	17,098	48.60	47.98	48.29	48.96
Gulf	2,083	2,432	3,069	4,056	12.38	12.37	11.91	11.61
Pacific South	2,318	2,684	3,360	4,290	14.00	13.66	13.03	12.28

[a]Source: Anuario Estadistico de los Estados Unidos Mexicanos. (Several) S.I.C. Mexico.

[b]Estimates are based on information from the previous source.

[c]There exists a difference with the figure reported which is 25,791 - 25,779 = 12 thousand. The only explanation in the Anuario says: "complementary census". However, these 12,000 inhabitants correspond only to the urban population.

Table 19. Population by regions and residence[a]

Zone	Distribution of the rural population (Thousands of inhabitants)				Percentage with respect to total population by regions			
	1930	1940	1950	1960	1930	1940	1950	1960
Mexico	11,012	12,757	14,808	17,218	66.5	64.9	57.4	49.3
Pacific North	666	854	1,050	1,242	68.3	70.9	72.0	47.5
North	2,061	2,521	2,988	3,341	65.8	64.6	64.6	48.7
Central	4,956	5,471	6,233	7,114	61.6	58.0	50.0	41.6
Gulf	1,424	1,661	1,947	2,321	68.4	68.2	63.4	57.2
Pacific South	1,905	2,250	2,590	3,200	81.8	83.8	77.1	74.6

[a]Source: Anuario de los Estados Unidos Mexicanos (Several), S.I.C., Mexico.

Table 20. Corn: Area harvested, yield, production and farm price, 1930-65[a]

Year	Area Thousands of hectares	Yield Kg/Ha	Production Thousands of tons	Farm price Pesos/tons
1930	3,075	448	1,377	80
31	3,378	633	2,139	50
32	3,243	609	1,973	50
33	3,198	601	1,924	50
34	2,270	580	1,723	50
1935	2,966	565	1,675	60
36	2,852	560	1,597	80
37	3,000	545	1,635	120
38	3,094	547	1,693	110
39	3,267	605	1,977	100
1940	3,342	491	1,640	100
41	3,492	608	2,124	100
42	3,758	628	2,363	113
43	3,083	587	1,808	174
44	3,355	690	2,316	251
1945	3,451	634	2,186	274
46	3,313	719	2,383	285
47	3,512	717	2,518	313
48	3,722	761	2,832	303
49	3,792	757	2,871	294
1950	4,328	721	3,122	387
51	4,428	773	3,424	500
52	4,236	756	3,202	500
53	4,857	766	3,722	499
54	5,253	854	4,488	515
1955	5,371	836	4,490	526
56	5,460	803	4,382	636
57	5,392	835	4,500	700
58	6,372	828	5,277	709
59	6,324	880	5,563	715
1960	5,415	995	5,386	729
61	6,288	993	6,246	749
62	6,372	995	6,337	762
63	6,963	987	6,870	940
64	7,461	1,133	8,454	950
1965	7,718	1,124	8,678	940

[a]Source: 1930-60. Consumos Aparentes, Departamento de Programa Agricola y Forestal, SAG. (Department of Agricultural Programming and Forestry, Secretariat of Agriculture and Livestock.) 1961-65. DGEA/SAG Boletin de Economia Agricola (Several) 1964 and 1965 are preliminary data.

Table 21. Beans: Area harvested, yield, production and farm price, 1930-65[a]

Year	Area Thousands of hectares	Yield Kg/Ha	Production Thousands of tons	Farm price Pesos/tons
1930	709	116	83	191
31	723	188	136	126
32	640	206	132	110
33	662	281	186	60
34	597	207	124	70
1935	568	213	121	100
36	528	202	107	140
37	547	190	104	200
38	596	177	105	250
39	632	234	148	240
1940	635	152	97	210
41	672	238	160	210
42	750	244	183	200
43	700	225	157	230
44	734	249	183	290
1945	728	222	162	370
46	734	189	139	680
47	741	268	199	820
48	788	266	210	680
49	886	261	231	690
1950	969	258	250	720
51	969	248	240	700
52	965	253	245	740
53	980	305	299	770
54	1,108	361	399	890
1955	1,187	377	449	1,028
56	1,343	322	432	1,115
57	1,115	356	410	1,246
58	1,349	378	510	1,278
59	1,411	412	581	1,320
1960	1,320	398	528	1,340
61	1,627	447	723	1,560
62	1,674	392	656	1,650
63	1,711	396	677	1,690
64	2,091	426	892	1,730
1965	2,117	407	858	1,700

[a]Source: 1930-60. Consumos Aparentes, Departamento de Programa Agricola y Forestal, SAG. (Department of Agricultural Programming and Forestry, Secretariat of Agriculture and Livestock.) 1961-65. DGEA/SAG Boletin de Economia Agricola (Several) 1964 and 1965 are preliminary data.

Table 22. Wheat: Area harvested, yield, production and farm price, 1930-65[a]

Year	Area	Yield	Production	Farm price
	Thousands of hectares	Kg/Ha	Thousands of tons	Pesos/tons
1930	490	756	370	107
31	604	869	525	69
32	445	703	313	89
33	472	830	392	120
34	493	719	354	133
1935	460	753	347	115
36	508	864	439	124
37	484	708	342	186
38	501	771	386	189
39	563	761	429	182
1940	601	772	464	183
41	583	745	434	185
42	600	815	489	189
43	510	715	364	246
44	527	710	374	288
1945	468	740	347	307
46	415	819	340	409
47	499	846	422	439
48	577	827	477	459
49	535	941	503	472
1950	644	911	587	549
51	673	877	590	750
52	593	863	512	733
53	657	1,020	670	755
54	765	1,098	839	781
1955	800	1,063	850	796
56	937	1,326	1,243	825
57	958	1,437	1,377	848
58	840	1,592	1,337	862
59	937	1,351	1,266	877
1960	840	1,417	1,190	868
61	837	1,676	1,402	912
62	748	1,946	1,455	893
63	819	2,079	1,703	920
64	743	2,056	1,527	940
1965	666	2,401	1,599	930

[a]Source: 1930-60. Consumos Aparentes, Departamento de Programa Agricola y Forestal, SAG. (Department of Agricultural Programming and Forestry, Secretariat of Agriculture and Livestock.) 1961-65. DGEA/SAG Boletin de Economia Agricola (Several) 1964 and 1965 are preliminary data.

Table 23. Rice: Area harvested, yield, production and farm price, 1930-65[a]

Year	Area Thousands of hectares	Yield Kg/Ha	Production Thousands of tons	Farm price[b] Pesos/tons
1930	27	1,278	51	110
31	36	1,361	49	100
32	34	1,441	49	80
33	33	1,394	46	90
34	32	1,469	47	90
1935	31	1,548	48	100
36	40	1,475	59	110
37	40	1,025	51	130
38	39	1,385	54	140
39	45	1,555	70	150
1940	62	1,177	73	170
41	53	1,396	74	270
42	65	1,138	74	240
43	66	1,181	78	290
44	68	926	63	340
1945	59	1,356	80	420
46	64	1,437	92	460
47	72	1,263	91	440
48	82	1,317	108	420
49	108	1,130	122	430
1950	106	1,160	123	440
51	104	1,144	119	440
52	82	1,219	100	460
53	94	1,063	100	520
54	90	1,244	112	530
1955	96	1,430	138	795
56	115	1,348	155	847
57	117	1,350	158	859
58	121	1,380	167	873
59	127	1,354	172	891
1960	143	1,510	216	928
61	146	1,507	220	1,008
62	134	1,425	191	1,060
63	135	1,444	195	1,080
64	133	1,360	181	1,090
1965	153	1,647	252	

[a]Source: 1930-60. Consumos Aparentes, Departamento de Programa Agricola y Forestal, SAG. (Department of Agricultural Programming and Forestry, Secretariat of Agriculture and Livestock.) 1961-65. DGEA/SAG Boletin de Economia Agricola (Several) 1964 and 1965 are preliminary data.

[b]Farm price corresponds to "rice with its husk".

Table 24. Supply and distribution of corn, corrected data, 1930-1965 (thousands of tons)[a]

Year	Imports	Production[b]	Total supply	Domestic use	Exports
1930	79	1,981	2,060	2,060	-c
31	19	2,808	2,827	2,827	
32	-c	2,708	2,708	2,708	-c
33	-c	2,723	2,723	2,723	
34	-c	2,588	2,588	2,517	71
1935	-c	2,604	2,604	2,523	81
36	-c	2,591	2,591	2,587	4
37	4	2,694	2,698	2,698	-c
38	22	2,817	2,839	2,839	
39	54	3,165	2,219	2,219	-c
1940	8	2,914	2,922	2,922	
41	-c	3,485	3,485	3,485	-c
42	1	3,810	3,811	3,811	-c
43	1	3,341	3,342	3,342	-c
44	164	3,935	4,099	4,099	-c
1945	49	3,891	3,940	3,940	
46	10	4,173	4,183	4,182	1
47	1	4,394	4,395	4,395	-c
48	-c	4,794	4,794	4,794	-c
49	-c	4,919	4,919	4,904	15
1950	-c	4,971	4,971	4,972	
51	51	5,074	5,125	5,125	
52	25	4,653	4,678	4,678	
53	377	4,974	5,351	5,351	
54	147	5,541	5,688	5,688	c
1955	1	5,344	5,345	5,286	59
56	119	5,037	5,156	5,155	1
57	819	4,956	5,775	5,768	7
58	810	5,534	6,344	6,344	
59	48	5,622	5,670	5,670	
1960	26	5,245	5,271	4,814	457
61	31	5,221	5,252	5,252	-c
62	100	5,798	5,898	5,895	4
63	475	6,229	6,704	6,704	-c
64	45	5,232	5,277	5,004	273
1965	5	7,729	7,734	6,534	1,200

[a]Source: Anuario Estadistico de los Estados Unidos Mexicanos, (several) S.I.C. (Secretariat of Industry and Commerce), Mexico.

[b]Corrected production, see adjustment procedure explained in the text.

[c]Less than 500 tons.

Table 25. Supply and distribution of beans, corrected data, 1930-1965[a] (thousands of tons)

Year	Imports	Production[b]	Total supply	Domestic use	Exports
1930	4	78	82	81	1
31	8	134	142	142	-c
32	-c	132	132	132	-c
33	-c	188	188	182	6
34	-c	128	128	116	12
1935	-c	128	128	122	6
36	-c	115	115	114	1
37	-c	115	115	114	1
38	-c	119	119	119	-c
39	4	170	174	174	-c
1940	-c	130	130	129	1
41	-c	205	205	197	8
42	-c	239	239	227	12
43	-c	225	225	220	5
44	-c	263	263	258	5
1945	-c	253	253	246	7
46	-c	241	241	240	1
47	2	313	315	315	-c
48	-c	335	335	335	-c
49	-c	368	368	368	-c
1950	-c	382	382	381	1
51	12	367	379	379	-c
52	65	366	431	431	
53	50	416	466	466	-c
54	19	511	530	530	-c
1955	9	556	565	556	9
56	10	534	544	533	11
57	7	507	514	509	5
58	38	601	639	639	
59	41	668	709	709	-c
1960	25	610	635	635	-c
61	10	694	704	704	-c
62	3	727	730	728	2
63	9	744	753	721	32
64	8	767	775	755	20
1965		1,002	1,002	971	30

[a]Source: Anuario Estadistico de los Estados Unidos Mexicanos, (several), S.I.C., Mexico.

[b]Corrected production, see procedure of adjustment in the text.

[c]Less than 500 tons.

Table 26. Supply and distribution of wheat, corrected data, 1930-1965[a] (thousands of tons)

Year	Imports	Production[b]	Total supply	Domestic use	Exports
1930	70	287	357	357	
31	30	449	479	479	
32	-c	244	244	244	
33	2	331	333	333	
34	-c	301	301	301	
1935	-c	301	301	301	
36	-c	401	401	401	
37	5	312	317	317	-c
38	90	363	453	453	-c
39	51	408	459	459	
1940	1	445	446	446	
41	124	418	542	542	
42	130	475	595	595	
43	297	352	649	649	
44	439	362	801	801	
1945	312	337	649	649	
46	260	333	593	593	
47	279	418	697	697	
48	287	476	763	763	
49	251	504	755	746	9
1950	427	569	796	996	
51	378	553	931	931	
52	452	456	908	908	
53	249	595	844	844	
54	69	745	814	814	
1955	10	736	746	746	-c
56	85	1,110	1,195	1,195	-c
57	19	1,249	1,268	1,268	-c
58	-c	1,166	1,166	1,166	
59	1	1,076	1,077	1,077	
1960	-c	981	981	981	-c
61	-c	1,145	1,145	1,146	-c
62	29	1,227	1,256	1,256	1
63	51	1,437	1,488	1,416	72
64	64	1,405	1,469	893	576
1965	50	1,784	1,834	1,438	396

[a]Source: Anuario Estadistico de los Estados Unidos Mexicanos, (Several), S.I.C., Mexico.

[b]Corrected production, see procedure of adjustment in the text.

[c]Less than 500 tons.

Table 27. Supply and distribution of rice, corrected data, 1930-1965[a] (thousands of tons)

Year	Imports	Production[b]	Total supply	Domestic use	Exports
1930	1	79	80	80	-c
31	-c	80	80	76	4
32	-c	82	82	81	1
33	-c	81	81	75	6
34	-c	85	85	77	8
1935	-c	88	88	70	18
36	-c	101	101	88	13
37	-c	96	96	76	20
38	1	102	103	97	6
39	-c	120	120	118	2
1940	-c	123	123	123	-c
41	-c	124	124	117	7
42	-c	123	123	100	23
43	-c	127	128	125	3
44	-c	111	111	111	
1945	-c	129	129	129	
46	1	142	143	143	-c
47	2	139	141	131	10
48	-c	156	156	127	29
49	-c	168	168	127	41
1950	-c	168	168	168	
51	-c	161	161	161	
52	-c	141	141	141	
53	-c	139	139	139	-c
54	-c	150	150	150	-c
1955	-c	174	174	174	
56	-c	189	189	188	1
57	-c	190	190	184	6
58	1	197	198	190	8
59	1	201	202	192	10
1960	22	243	265	263	2
61	5	245	250	247	3
62	-c	216	216	153	63
63	3	217	220	220	-c
64	2	216	218	218	
1965		239	239	239	

[a]Source: Anuario Estadistico de los Estados Unidos Mexicanos, (several), S.I.C., Mexico.

[b]Corrected production, see procedure of adjustment in the text.

[c]Less than 500 tons.

Table 28. Annual population[a]
(thousands of inhabitants)

Year	Census population	Natural rate[b]	Interpolated population[c]	Definitive population[c]
1930	16,553	12.8	16,152	16,553
31		17.9	16,446	16,807
32		17.2	16,734	17,005
33		16.5	17,015	17,296
34		20.5	17,371	17,612
1935		19.7	17,719	17,920
36		19.5	18,072	18,233
37		19.7	18,435	18,556
38		20.6	18,823	18,904
39		21.6	19,239	19,280
1940	19,654	21.1	19,654	19,654
41		21.4	20,075	20,126
42		22.7	20,531	20,634
43		23.1	21,005	21,159
44		23.6	21,501	21,707
1945		25.4	22,047	22,304
46		24.3	22,583	22,891
47		29.5	23,249	23,609
48		28.3	23,907	24,316
49		27.3	24,559	25,021
1950	25,791	29.3	25,278	25,791
51		27.3	26,495	26,376
52		28.8	27,258	27,002
53		29.1	28,051	27,897
54		33.3	28,985	28,424
1955		32.7	29,843	29,254
56		34.7	30,878	30,171
57		34.1	31,931	31,106
58		32.3	32,962	32,020
59		35.8	34,142	33,082
1960	34,923	34.5	35,320	34,923
61		35.0	36,145	36,145
62		35.0	37,410	37,410
63		35.0	38,719	38,719
64		36.4	40,128	40,128
1965		36.0	41,573	41,573

[a]Source: Censo General de Poblacion (1930, 1940, 1950 and 1960), Secretariat of National Economy, and Secretariat of Industry and Commerce, Mexico. Anuario Estadistico de los Estados Unidos Mexicanos (several), S.I.C., Mexico.

[b]Birth rate - death rate.

[c]See procedure in the text.

Table 29. Rural annual population[a]
(thousands of inhabitants)

Year	Total population	Percent of rural census population	Rural population[b]	Percent of rural population
1930	16,553	66.54	11,013	66.54
31	16,807		11,174	66.48
32	17,055		11,339	66.48
33	17,296		11,509	66.52
34	17,612		11,677	66.30
1935	17,920		11,850	66.12
36	18,233		12,025	65.95
37	18,556		12,204	65.76
38	18,904		12,385	65.51
39	19,280		12,570	65.19
1940	19,654	64.9	12,757	64.90
41	20,126		12,947	64.32
42	20,634		13,141	63.68
43	21,159		13,338	63.03
44	21,707		13,537	62.36
1945	22,304		13,741	61.60
46	22,891		13,947	60.92
47	23,609		14,157	59.96
48	24,316		14,370	59.09
49	25,021		14,587	58.29
1950	25,791	57.4	14,807	57.41
51	26,376		15,032	56.99
52	27,022		15,259	56.46
53	27,897		15,491	55.52
54	28,424		15,724	55.31
1955	29,254		15,965	54.57
56	30,171		16,208	53.72
57	31,106		16,454	52.89
58	32,020		16,705	52.17
59	33,082		16,960	51.26
1960	34,923	49.3	17,218	49.30
61	36,145		17,482	48.34
62	37,410		17,749	47.44
63	38,719		18,021	46.54
64	40,128		18,296	45.59
1965	41,573		18,576	44.68

[a]Source: Censos General de Poblacion (several), S.I.C., Mexico.

[b]Calculated according to procedure in the text.

Table 30. Simultaneous estimation in "reduced form", DGEA data

Price	R^2	Constant term	q_c	q_b	q_w	q_r	I'	I
P_m	0.99	1.0184	+0.2693 (0.2514)	-0.5538 (0.1710)	+0.1474 (0.1585)	-0.0807 (0.1131)	+0.0904 (0.6955)	+0.9059 (0.5309)
P_f	0.96	4.8153	+0.8860 (0.5143)	-0.6637 (0.3498)	-0.0848 (0.3244)	+0.1800 (0.2314)	-1.4610 (14230)	+0.0974 (1.0864)
P_t	0.98	0.1382	+0.2845 (0.2420)	-0.1222 (0.1646)	-0.4457 (0.1526)	+0.0442 (0.1089)	+0.8622 (0.6696)	+0.2861 (0.5112)
P_a	0.99	0.5604	+0.5234 (0.2373)	-0.2288 (0.1614)	-0.3014 (0.1497)	-0.0157 (0.1069)	+0.8087 (0.6566)	-0.0794 (0.5013)
				Corrected data				
P_m	0.99	0.8919	+0.5226 (0.2941)	-0.6943 (0.1630)	+0.1045 (0.1373)	-0.0286 (0.1589)	+0.1429 (0.7697)	+0.9667 (0.6649)
P_f	0.96	7.7425	+1.1424 (0.6235)	-0.7881 (0.3456)	-0.1359 (0.2910)	+0.2541 (0.3370)	-3.1578 (1.6321)	+1.7867 (1.4099)
P_t	0.99	1.9460	+0.6635 (0.2895)	-0.2215 (0.1605)	-0.4373 (0.1352)	+0.1486 (0.1565)	+0.0150 (0.7579)	+1.1914 (0.6547)
P_a	0.99	1.6814	+0.5818 (0.2913)	-0.1833 (0.1614)	-0.3199 (0.1359)	-0.0489 (0.1574)	+0.1552 (0.7625)	+0.6774 (0.6587)

Table 31. Reduced form with agricultural income estimated, corrected data, 1930-65

Price	R^2	Constant term	q_c	q_b	q_w	q_r	I'	I
P_m	.90	4.3733	-0.1847 (0.6203)	+0.5368 (0.4008)	+0.3860 (0.4125)	+0.2135 (0.4507)	+0.9571 (0.4733)	+1.1231 (0.5214)
P_f	.87	6.3942	+0.1044 (0.8280)	+0.6666 (0.5349)	+0.1886 (0.5506)	+0.6096 (0.6016)	+1.5457 (0.6318)	+0.3322 (0.6959)
P_t	.91	4.5254	+0.1708 (0.5096)	+0.6680 (0.3292)	-0.1569 (0.3389)	+0.2969 (0.3703)	+0.9112 (0.3888)	+0.8111 (0.4283)
P_a	.93	4.5958	+0.1326 (0.5666)	+0.7687 (0.3661)	-0.0830 (0.3768)	+0.1696 (0.4117)	+1.2408 (0.4323)	+0.8277 (0.4762)
					1940-65			
P_m	.83	7.0301	-0.0884 (0.7944)	+1.4355 (0.6608)	+0.3957 (0.5127)	+0.5606 (0.5401)	+0.3894 (0.7015)	+0.4191 (0.6698)
P_f	.84	8.6012	+0.2094 (0.9240)	+2.2107 (0.7686)	-0.3343 (0.5963)	+0.7129 (0.6282)	+0.3897 (0.8159)	-0.2606 (0.7791)
P_t	.88	7.2801	+0.3399 (0.6110)	+1.3157 (0.5082)	-0.0256 (0.3943)	+0.7433 (0.4154)	+0.5867 (0.5395)	+0.1072 (0.5152)
P_a	.90	7.9342	+0.2262 (0.7654)	+1.7890 (0.6366)	-0.1540 (0.4939)	+0.6448 (0.5204)	+0.5022 (0.6958)	+0.1329 (0.6453)

Table 32. Supply and distribution of corn, (thousands of tons), 1953-66[a,b]

Year	Carry in	Imports	Production	Total supply	Direct use	Domestic use	Exports	Carry out
1953-54	200	145	3,200	3,545	3,145	300	-c	100
1954-55	100	-c	4,000	4,100	3,360	400	40	300
1955-56	300	123	4,490	4,920	4,909	607	1	222
1956-57	222	818	4,382	5,422	4,182	700	7	533
1957-58	533	850	4,100	5,483	4,200	800	-c	483
1958-59	483	32	5,276	5,791	4,396	643	-c	752
1959-60	752	8	5,563	6,323	4,550	950	457	366
1960-61	366	10	5,000	5,376	4,276	900	-c	200
1961-62	200	27	5,561	5,788	4,754	931	3	100
1962-63	100	450	5,450	6,000	4,825	975	-c	200
1963-64	200	120	6,424	6,744	5,100	990	286	368
1964-65	368	20	7,500	7,888	6,500	-d	1,200	188
1965-66	188	5	7,900	8,093	6,700	-d	11,200	193

[a]Source: FAS, USDA, Mexico.

[b]Corresponds to the first cycle of October to September 30 of each year.

[c]Less than 500 tons.

[d]Not available.

Table 33. Supply and distribution of beans, (thousands of tons) 1953-66[a,b]

Year	Carry in	Imports	Production	Total supply	Direct use	Domestic use	Exports	Carry out
1953-54	10	19	300	329	309	_d	_c	20
1954-55	20	5	360	385	325	_d	10	50
1955-56	50	10	449	509	385	_d	11	113
1956-57	113	7	432	552	440	_d	5	107
1957-58	107	32	310	449	339	_d	0	110
1958-59	110	41	510	661	510	_d	_c	146
1959-60	146	38	600	784	570	_d	_c	214
1960-61	214	50	620	884	685	_d	_c	199
1961-62	199	3	617	819	649	_d	2	168
1962-63	168	9	633	810	620	_d	32	158
1963-64	158	8	892	1,058	834	_d	30	194
1964-65	194	_d	903	1,098	860	_d	15	223
1965-66	223	_d	945	1,163	875	_d	30	260

[a]Source: FAS, USDA, Mexico.

[b]Corresponds to the first cycle of October to September 30 of each year.

[c]Less than 500 tons.

[d]Not available.

Table 34. Supply and distribution of wheat, (thousands of tons) 1953-66[a,b]

Year	Carry in	Imports	Production	Total supply	Direct use	Domestic use	Exports	Carry out
1953-54	200	62	825	1,057	907	_d	_c	180
1954-55	180	25	825	1,030	940	_d	_c	90
1955-56	90	85	1,243	1,418	942	_d	_c	476
1956-57	476	_c	1,376	1,852	1,170	_d	_c	682
1957-58	682	_c	1,250	1,932	1,320	_d	_c	612
1958-59	612	_c	1,266	1,878	1,378	_d	_c	500
1959-60	500	_c	1,190	1,690	1,390	_d	_c	300
1960-61	300	_c	1,350	1,650	1,400	_d	_c	250
1961-62	250	25	1,502	1,777	1,611	_d	_c	166
1962-63	166	48	1,766	1,974	1,539	_d	270	165
1963-64	165	46	2,100	2,311	1,620	_d	545	146
1964-65	146	50	2,000	2,196	1,585	_d	396	219
1965-66	_d	_d	_d	_d	_d	_d	_d	_d

[a]Source: FAS, USDA, Mexico.

[b]Corresponds to the first cycle of October to September 30 of each year.

[c]Less than 500 tons.

[d]Not available.

Table 35. Supply and distribution of rice, (thousands of tons) 1953-66[a,b]

Year	Carry in	Imports	Production	Total supply	Direct use	Domestic use	Exports	Carry out
1953-54	5	_c	152	157	132	15	_c	10
1954-55	10	-c	172	182	135	15	-c	32
1955-56	32	-c	210	242	176	44	2	18
1956-57	18	-c	235	253	206	24	8	15
1957-58	15	1	240	256	217	24	12	3
1958-59	3	-b	261	264	215	25	15	9
1959-60	9	34	270	313	255	25	3	30
1960-61	30	-d	290	320	270	25	2	23
1961-62	23	_d	397	420	272	35	91	22
1962-63	22	5	309	336	273	40	0	23
1963-64	23	2	308	333	280	40	0	13
1964-65	13	18	340	368	288	40	0	40
1965-66	_d	_d	_d	_d	_d	_d	_d	_d

[a]Source: FAS, USDA, Mexico.

[b]Cycle not specified.

[c]Less than 500 tons.

[d]Not available.

Table 36. Reduced form to derive price elasticities and cross demand for four commodities using adjusted consumption with income elasticities, 1930-65[a]

Prices	R^2	Constant term	q_c	q_b	q_w	q_r
P_c	0.86	5.1809	0.4866 (0.6749)	1.2933 (0.3697)	0.0539 (0.4547)	-0.0851 (0.4859)
P_b	0.84	5.8937	0.5344 (0.8411)	1.5003 (0.4607)	-0.2331 (0.5666)	0.1006 (0.6055)
P_w	0.87	4.8152	0.5274 (0.5090)	1.1160 (0.2788)	-0.3616 (0.3429)	0.0953 (0.3664)
P_r	0.91	5.1328	0.5336 (0.5755)	1.3336 (0.3153)	-0.3483 (0.3878)	-0.1088 (0.4143)

[a]This adjustment was made with the estimates of the rural and urban income elasticity for the four commodities, calculated with cross section data by the Office of Agricultural Projections of the Bank of Mexico, S.A. The numbers in parenthesis are the standard errors of the coefficients.

Table 37. Reduced form for purpose of price prediction using adjusted data, 1930-65

Prices	R^2	Constant term	Q_c	Q_b	Q_w	Q_r	L	Y
P_c	.97	3.0239	+1.0619 (0.4083)	-0.5658 (0.2564)	-0.0017 (0.2260)	+0.2487 (0.2468)	-4.3871 (1.1772)	+3.4691 (0.6248)
P_b	.92	-1.0723	+1.6307 (0.7752)	-0.4412 (0.4868)	-0.2808 (0.4305)	+0.5959 (0.4685)	-2.9906 (2.2348)	+2.5822 (1.1861)
P_w	.98	1.8471	+1.0930 (0.3273)	-0.1711 (0.2055)	-0.4913 (0.1817)	+0.3352 (0.1978)	-3.1512 (0.9435)	+2.5943 (0.5007)
P_r	.97	3.8303	+1.1311 (0.4105)	-0.0554 (0.2578)	-0.4267 (0.2279)	+0.2313 (0.2481)	-4.2634 (1.1834)	+3.2123 (0.6281)

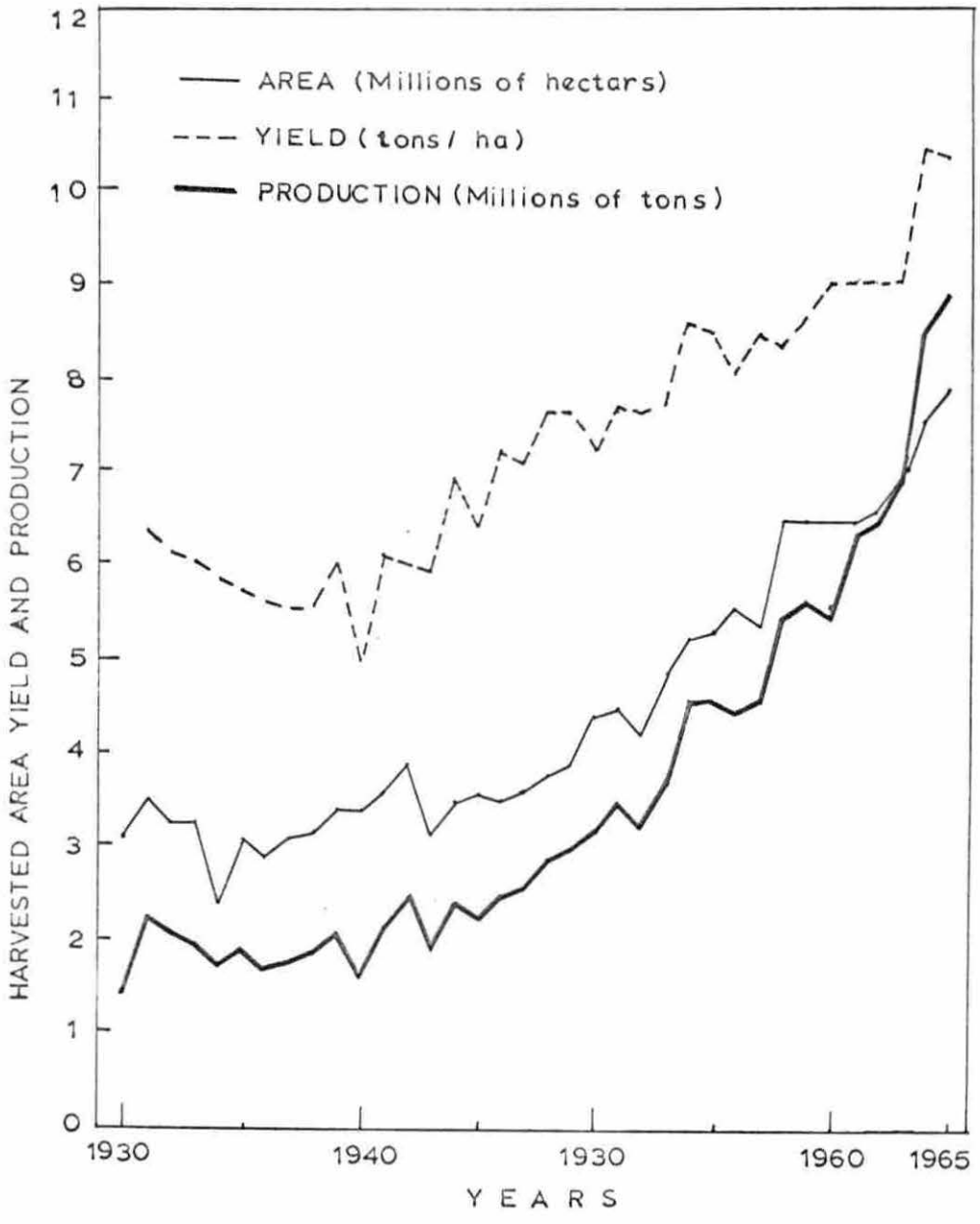


Figure 7. Harvested area, yield and production for corn, 1930-65

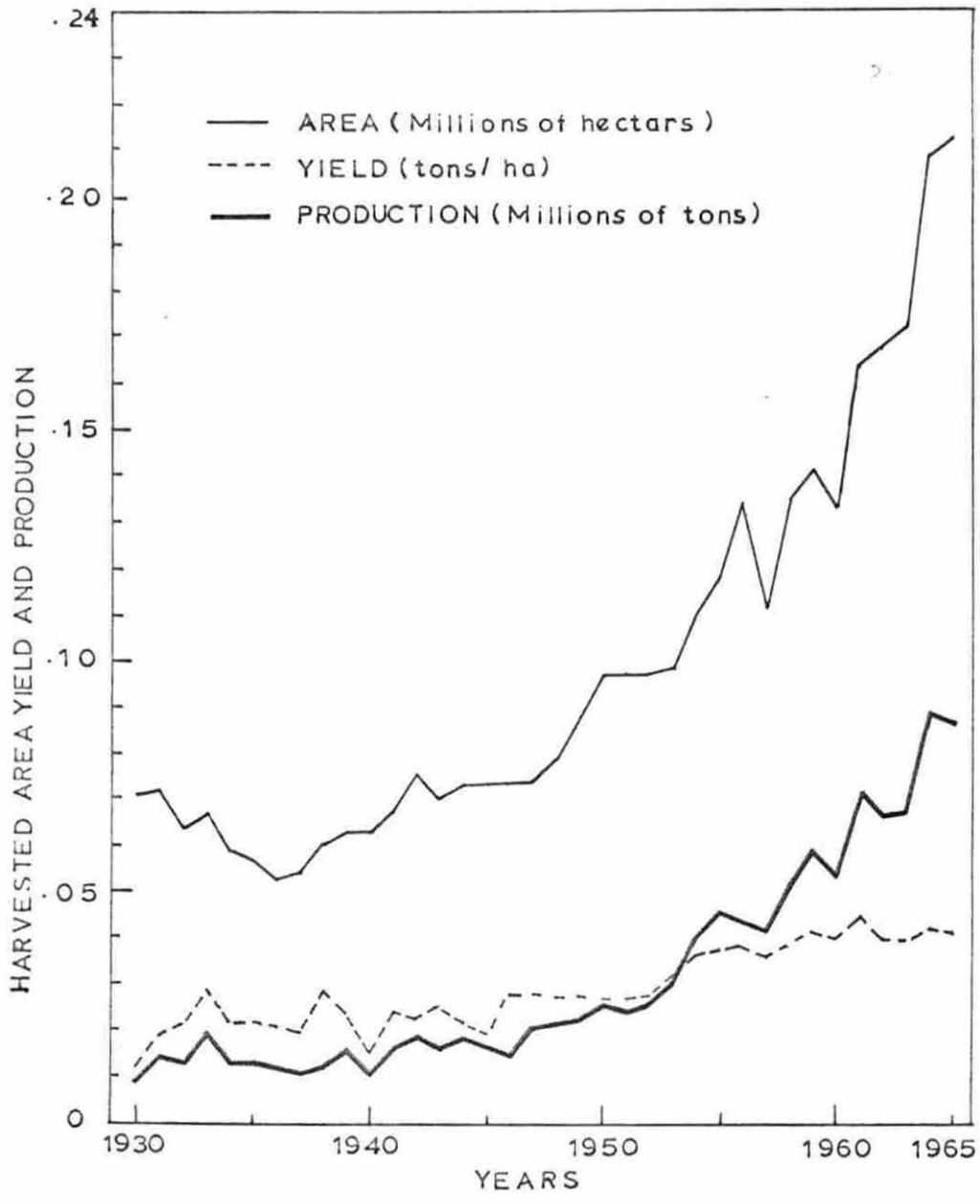


Figure 8. Harvested area, yield and production for beans, 1930-65

Figure 9. Harvested area, yield and production for wheat, 1930-65

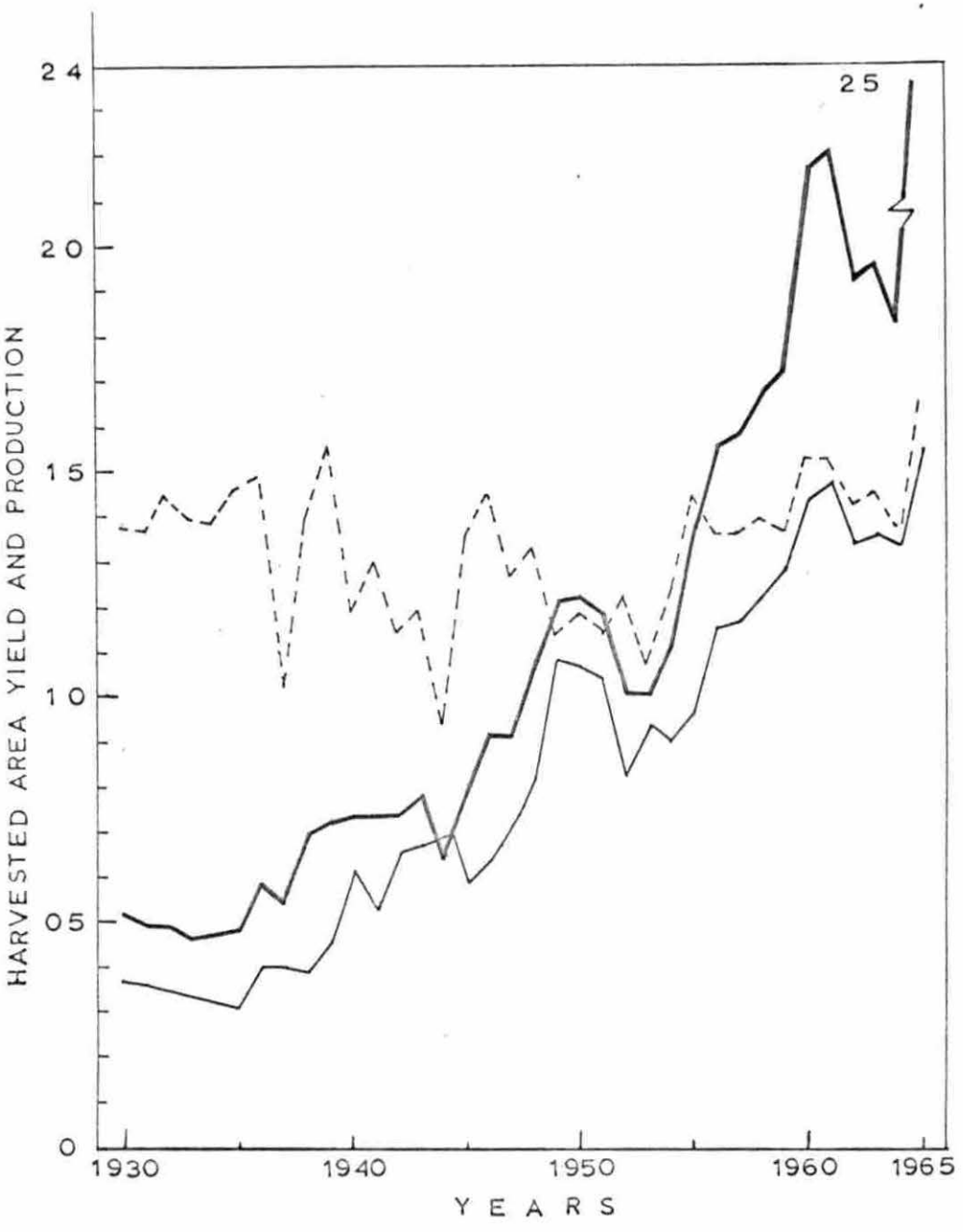


Figure 10. Harvested area, yield and production for rice, 1930-65